Diseases of Middle Life

THE PREVENTION, RECOGNITION AND TREATMENT OF
THE MORBID PROCESSES OF SPECIAL SIGNIFICANCE
IN THIS CRITICAL LIFE PERIOD

*COMPRISING TWENTY-TWO ORIGINAL ARTICLES
BY VARIOUS EMINENT AUTHORITIES*

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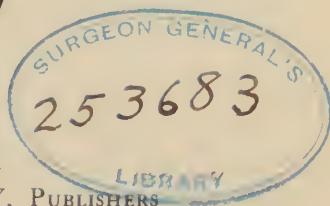OF THE HENRY PHIPPS INSTITUTE OF THE UNIVERSITY
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PREFACE

THE following system has been compiled with the object of presenting to the medical profession a series of monographs covering those diseases which are most common during middle life or which have a bearing upon the health, efficiency, and well-being of the individual during that important period.

No definite limitation has been placed upon the age period to be included under the title "middle life", the term being employed in an elastic sense, to be interpreted or defined by each contributor as he considers it applies particularly to the subject covered by his section. The diseases of childhood and the acute infectious diseases have been purposely omitted from any special consideration, except as they may be discussed by the various contributors in their relation to other disease processes. No special sections have been devoted to the consideration of tuberculosis or syphilis, as it was believed that these two diseases should be considered by the various writers in their descriptions of their manifestations in the organs or groups of organs forming the subject of their articles. Articles dealing with general subjects, such as diet, exercise, and occupation have been added as constituting essential features of a work, the purpose of which is to present a comprehensive study of all the factors which may influence the later years of the individual, the mode of life being equally as important in this regard as the disease processes which may be present.

This age period has been selected for special consideration because it is during this time of life that one notes the first appearance of many of those maladies which have the most important bearing upon the length of life of the individual, and upon the efficiency and well-being of old age. Nearly all of these disease processes are most amenable to treatment during their early stages, at a time when the evidence of their presence is first manifested, as in the majority of them, after they have become well established or advanced,

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our therapeutic measures can only serve as a means of check-
ing the progress of the process, or an aid in counteracting
their injurious effect The recognition of their presence
during middle life is, therefore, essential if the individual is
to enjoy the greatest possible degree of usefulness in his
later years.

During recent years periodic health examinations have
been strongly recommended as a method of discovering evi-
dence of disease in the early stages of the process, and numer-
ous contributions have been made indicating the signs to be
sought in these examinations and what interpretation should
be placed upon their presence; while the significance of these
variations from the normal, from the standpoint of the future
of the individual, and the treatment to be followed to pre-
vent their further development, have not received the atten-
tion that their importance would warrant. It has been the
hope of the editor that in the following pages could be
collected together a series of articles which would assist the
physician in his important task of directing, advising and
treating those individuals in whom the examination has
revealed the presence of some signs or symptoms indicative
of a beginning pathological process, and to provide a basis
upon which to estimate their relative importance from the
standpoint of efficiency and duration of life, at the same time
supplying him with an outline of the most approved methods
for the detection of these evidences of disease.

It is during middle life that the majority of individuals
attain their period of greatest usefulness and value to the
community, many of them holding positions of the greatest
responsibility so that their health and strength is of the
greatest moment to themselves and frequently to numerous
others, even at times the welfare of an entire nation being
dependent upon the state of health of one individual. It is,
therefore, only right and proper that this age-group should
receive the most careful consideration of the physician who
should urge their reporting for frequent observation and
study in order that he may detect the first evidence of
beginning disease, the first indications of wear and tear, or
the signs suggestive of injurious effects of previous disease
or injury; and that he may further be in a position to so

direct the individual that their deleterious influence may be overcome.

This outline of the purpose of the work has been briefly stated in order to make clear the fact that while all of the diseases which are covered in these two volumes are the same as those which are included in any system of medicine they have been here approached from a different angle and presented in a form unlike that usually employed.

There are numerous works dealing with old age, its peculiarities, characteristics and manifestations, and the special features of disease occurring in that period, together with their appropriate treatment—many books have been written upon the prolongation of life, usually by men who are firm believers in some special method of treatment or some mode of life which they have reason to believe of special value. The following work is based upon the belief that the time to treat old age is during middle life and that the arrest or cure of disease in its early stages is the only logical and rational basis upon which can be formulated any method for the prolongation of life or for rendering old age an efficient and enjoyable period of existence instead of one of semi-invalidism as is unfortunately so frequently the case.

The contributors of the various sections have been selected on account of their special training, experience and judgment, each being an authority in the special branch covered by his article, and the editor feels that the medical profession at large is to be congratulated on the opportunity of having access to a system of this kind, compiled by such an authoritative and representative group of writers, who have each exhibited their enthusiasm and interest in the preparation of their material in an endeavor to achieve the purpose of the work.

After the entire first volume had been printed, the author of the article on diabetes believed that this section would be incomplete without some reference to *insulin,* which had been placed in the hands of the medical profession subsequent to the completion of Dr. Mohler's article. It was decided that a section dealing with this new remedial agent should be inserted, regardless of the technical difficulties involved. This

will explain why the reader will find that the pages of this section are not numerically uniform with the remainder of the volume.

The editor desires to take this opportunity of expressing his thanks to each and every one of the contributors, to the publishers, and to all who have in any way assisted in the preparation of these volumes, an assistance which has materially added to the pleasure the editor has derived from the preparation of a work which, he trusts, will be found useful to the medical profession.

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INTRODUCTION.

THERE is no subject which is of more general interest than the question of duration of life and vigor, although unfortunately it is not given any serious consideration by the average individual until he has noted some sign or indication that his efficiency has begun to decline. It may prove of interest to give some consideration to the question of duration of life, and the means which have been suggested for its prolongation in the past, with a review of the more recent attitude toward this subject.

There is considerable difference of opinion as to what should be regarded as the average age which the majority of individuals should reasonably expect to attain. The "threescore years and ten" has been held by many as the highest point which should be expected, although there are many writers who believe that one hundred years, or even one hundred and twenty years, represents the age which men should reach. A strong supporter of the view that one hundred years should be the age which man should look forward to is Metchnikoff,[1] who quotes statistics and data in support of his opinion, showing that it is not uncommon for individuals to attain this age and cites numerous instances, more or less authentic, of extreme longevity.

The life expectancy appears to be gradually increasing, according to Capt. W. E. Elliott,[2] who gives the following table:

1871 to 1880	....	41.0 years.
1881 " 1890	....	43.7 "
1891 " 1900	....	44.1 "
1901 " 1910	....	43.9 "
1911 " 1920	....	51.5 "
1921 " 1930*	....	50.4 "

In his work "On the Changes of the Human Body," in 1814 Jameson gives as the expectancy at six years of age: for

* Estimated.

England, thirty-six years in the City of London, and forty-
one years for the rural population; and giving forty-five years
for Sweden. In the United States the expectation for the
male, native, white, at ten years of age is given—by For-
sythe[3] in 1890—as 56.1, this falling to 54.1 in 1910. At the
age of forty the expectation was 32.8 in 1890, and 29.9 in
1910. The greater expectation of life in more recent years
in spite of the slight drop within the last two or three decades,
must be ascribed to our change in mode of life and to some
extent to the efforts along the lines of preventive medicine.
It must be borne in mind, as Jacques Loeb[4] has pointed out,
that "the efforts to prolong life have resulted merely in a
diminution of the chances of premature death—modern pre-
ventive medicine has succeeded in warding off many menaces
to life by conquering some of the dangerous infectious dis-
eases, and even threatening contagions. At best, however,
by such accomplishments each person is merely guaranteed
with greater degree of probability that he may enjoy the full
usual duration of life. Death is not averted. The problem of
prolonging life thus appears to consist either in finding an
antidote to the harmful products that gradually accumulate as
the result of the body's metabolism, or in replacing that sub-
stance responsible for youthful condition and gradually de-
stroyed in growth—or in both. At any rate, the bacteria no
longer have the odious distinction of being the sole enemies
of human longevity."

While then in the light of our present knowledge we are
not so concerned with means for prolonging life, in the true
sense of the term, as we are in securing for each individual
some method for ensuring him a life as long as he could
reasonably expect, and, what is really more important, to
secure for him an old age in which he may retain his mental
and physical fitness to the greatest possible degree. Our
attainments would be of relatively little value to an indi-
vidual if we secured him an additional ten years of life, if
those years were to be filled with pain, weakness, helpless-
ness and discomfort. The actual number of years a person
has lived is, within certain limits, no indication of his mental
or physical powers, many at the age of eighty years being
more valuable members of the community and deriving more

enjoyment from life than others at the age of seventy or even sixty-five.

There are probably a number of factors which to a greater or less degree determine the fitness in old age, among which are heredity, environment, mode of life, and the presence or absence of disease. This is hardly the place to consider in detail the first two factors mentioned, our interest being chiefly concerned with the mode of life and the diseases which may be present, as it is these two factors which the physicians may, to a certain degree, control and regulate. To be of any value, however, to an individual our efforts along these lines must be instituted at a time when they may serve as preventive measures, during that period of life when the degenerative processes have not made serious inroads upon the organs of the body. The time to prepare for old age is early in middle life, to detect beginning disease at a time when it is still amenable to treatment, and to so guide and direct the individual that the disease process may be so checked or corrected that it will not interfere with the fitness of the individual.

We have fortunately at our command a method of detecting disease in its early stages which must commend itself to every physician who has the welfare of his patients at heart, namely, periodic health examinations. There is no more valuable measure at our command for the early detection of disease, especially those in which the onset is so insidious as to be well-established, or even fairly advanced before the individual affected has become aware of the fact that he is really ill. In carrying out any extensive series of examinations upon individuals who consider themselves well the large number of defects discovered is astonishing to one unfamiliar with this type of work, defects which may appear trivial in themselves but which are potential disease-producing factors of the gravest significance, as well as definite indications of serious disease. The significance and value of these periodic health examinations have been already demonstrated in the industrial and commercial organizations where they have been in operation to a limited extent for some years. While many individual plants employ entrance examinations, the periodic health surveys have

not been so generally utilized. As an illustration of their value may be cited a study made by A. S. Knight,[5] president of the National Association of Life Insurance Medical Directors, who states that "the mortality of a special group of 5987 men who have taken voluntary medical examinations regularly since 1914, under the direction of one company, has been only fifty-three per cent. of the rate expected on standard insurance tables." He adds that "the company, in defraying the expenses of the tests for its policy holders, has had its principal returned and have made on the investment, through reduced insurance claims, a profit of two hundred per cent." It is unfortunate that we have no means of estimating the value of the increased efficiency and well-being, and extended period of earning power accruing to this group as a result of the periodic examinations. A few studies of this kind on large bodies of individuals, if they confirm the above findings, would soon convince the general public of the value and importance of visiting physicians at regular intervals for a complete physical examination.

This question of prolongation of life has attracted the attention of numerous writers from the time of David down to the present day. Among the ancients search was made for some elixir of life, and curious rites and charms were accredited with peculiarly potent virtue in the prevention of disease and accident, and with the ability to ensure to the performer or possessor a long and happy life. During the middle ages great value was attached to various concoctions and combinations of drugs, the employment of which were claimed to prolong life. In more recent years the tendency has been to discard this search for a specific means to prevent an untimely death and to insist upon an observance of the rules of hygiene and such preventive measures against disease as science has shown to be of value.

There have been a few exceptions to this general rule, where men of scientific standing have suggested definite lines of treatment which they believed possessed a specific value in the arrest of degenerative processes incident to old age. Without attempting an exhaustive consideration of the claims of all these investigators, one cannot leave this subject without referring to such men as Brown-Séquard, Metchnikoff,

and Varanoff. It was not so many years ago that Brown-
Séquard made his extravagant claims for his "serum," a
testicular emulsion, which the employment of his preparation
failed to substantiate. The theory upon which Metchnikoff
based his plan of prolonging life, was briefly that the de-
generative processes which are grouped under the heading
"old age" were to a large extent dependent upon or hastened
by the bacterial products with which the system was flooded,
being derived from the large intestine. He devoted a great
deal of study to the subject, although many of his arguments
and comparative illustrations are not as convincing as one
could desire. The plan he suggested for the correction of
this colonic infection with deleterious bacteria, was to change
the intestinal flora by the ingestion of cultures of bacteria of
certain kinds, the products of which were harmless to the
host and which had the ability to displace the other bacteria
by rendering the colon unsuitable for their growth. Within
recent years Varanoff has made claims for his method of
gland transplantation for the rejuvenation of the aged, for
substantiation of which we must await results

Numerous books have been written for the guidance of the
laity, telling them what they should do to prolong their lives
and well-being; these are, for the most part, of no practical
value to the physician who is called upon by the patient for
advice and direction as to the proper mode of life to follow
in the presence of certain infirmities or defects. Here the
physician needs special knowledge to suit the individual case,
a knowledge which no general work on hygiene will supply.

In the light of our present knowledge in regard to disease
and stress and their effect upon the individual, any work
which has for its object the prolongation of life, must, there-
fore, present not only the mode of life which seems best for
the average individual but specific directions to be followed
by those in which there are manifestations of some beginning
disease process, at the same time describing the early signs
of disease and their method of detection and significance.
For the work to be complete it is also necessary to describe
the most important etiological factors involved and their
prevention, and also, to complete the picture, to describe the
clinical manifestations of the disease when fully developed,

with the correct procedure to be followed in its treatment. There must remain for the present some uncertainty as to the relative importance of various factors in the production of disease, whether the stress and strain of life alone is most responsible or former disease conditions play the more important rôle. While this point has not yet been definitely settled, more and more prominence is being attached to the earlier or latent infections.

Clifford Allbutt[6] has well expressed our present views when he states: "On the insidious penetration of infections which corrupt the values of life, perhaps a few more paragraphs might have been written. Every day is adding to our knowledge in this matter; how such agents undermine and disintegrate the fabric of the body, with ultimate effects not for many years, perhaps, making themselves known; and then often in disguise. Of such, as Sir Hermann says, are certain cardioarterial degenerations; so that in the list of causes the part played by physical stresses becomes more and more restricted."

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Diet in Middle Life

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Diet in Middle Life.

Diet as a Means of Preventing Disease, Retarding Senile Changes and Prolonging Life. Almost all persons will agree that a proper diet is one of the most important factors in preventing the diseases peculiar to middle life and in retarding the onset and development of senile changes. Obviously a diet which attains these ends should alleviate suffering and prolong life. The attainment of such a desideratum may seem easy, but the practical accomplishment of it is in fact fraught with difficulty. While the potential possibilities of diet may be taken for granted, the means to attain the end desired are as debatable as they are various; much of the vast fund of information which is available is based upon empiricism or pure assumption. Scientifically established facts and reliable statistics are all too few. The character of our recommendations, moreover, will be largely determined by our preliminary definitions and limitations.

Middle life may be regarded as extending from forty to seventy, with subdivisions: forty to fifty-five, and fifty-five to seventy. Flourens, for example, divides the life of man as follows: Childhood, 1 to 10; youth, 10 to 20; young adult life, 20 to 40; middle age, 40 to 70 (40 to 55, 55 to 70); old age, 70 plus; extreme old age, 95 plus.

Persons of normal heredity and development who have not undergone unusual hardships or suffered from chronic ailments may preserve the characters of middle life to the limit of this term; others not so fortunate may present marked evidences of oncoming old age in the fifties. It is the aim of health extension to conserve the physical and mental processes unimpaired until the end of this period and beyond. Middle age is a purely artificial division of life, but corresponds to certain physiological and pathological peculiarities which justify the use of the expression. Before the beginning of this stage of life the organism has largely completed its development and thereafter may preserve a remarkable uniformity for a long period of time. The infections which are characteristic of youth and young adult life have

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before this largely expended their forces, while the atrophic changes characteristic of old age do not assume prominence until this epoch is drawing to a close. Between forty and fifty-five the sexual life in women comes to a close and coincidently there is frequently a marked change in the nutritive condition. Furthermore, certain diseases are more or less characteristic of middle life: Obesity, diabetes, gout, vascular hypertension, nephritis, asthma, gastric and hepatic disorders, endocrine disturbances, etc., affections which should above all others be amenable to prophylaxis by dietetic means. Cancer is also most common at this period, but is not amenable to diet. While this period, generally speaking, has a character of its own, it must not be forgotten that congenital and developmental influences may still be operative (epilepsy and dementia precox) while the evidences of oncoming age may be detected by careful observation. From one point of view we begin to grow old before we are born and Minot presents us with the paradox that old age is the period when the evidences of senility develop most slowly.

The modifications of diet necessitated by disease will be discussed in the chapters devoted to the particular pathological entities; the present chapter will deal only with the diet of the normal individual in middle life, or with such modifications as are indicated by inherited or acquired tendencies to disease or by vague disturbances which warn of impending disaster.

The Food Requirements of Middle Life as Modified by Various Factors. Our problem, then, will be to determine as far as possible the food requirements of the average healthy adult and the functions which they must subserve. We must give attention to physiological differences dependent upon age, height, weight, sex, varying degrees of exercise, climate, etc., as well as to the modifications conditioned by physical type and constitution. The latter will lead us to a consideration of various conditions, more or less pathological in character, which will limit the choice of foods in certain individuals. We shall then take up the dangers of hyperalimentation and subalimentation and the diseases which may result from or be associated with these lapses from the mean. The influence of alcohol, tobacco, coffee, tea and similar substances will be considered in relation to diet. From an analysis of all these factors, we shall hope to evolve some useful principles and practical applications.

Energy Requirements in Middle Life. The energy require-
ments of the human "machine" are conveniently calculated with
reference to the body weight, though more accurately, when com-
pared with the body surface, as determined by the "height-weight"
formula of DuBois. The body surface method of calculation has
been shown to be sufficiently exact, although the theoretical con-
siderations upon which it was based are now questioned—man
can no longer be considered a mere radiator. Thanks to the pains-
taking labors of DuBois and his co-workers, it is perfectly simple
by the use of a formula, or of the curve plotted by the use of
the formula (Chart 1), to estimate the body surface of any in-

CHART I.

(Dubois and Dubois, Arch. Int. Med., 1916.)
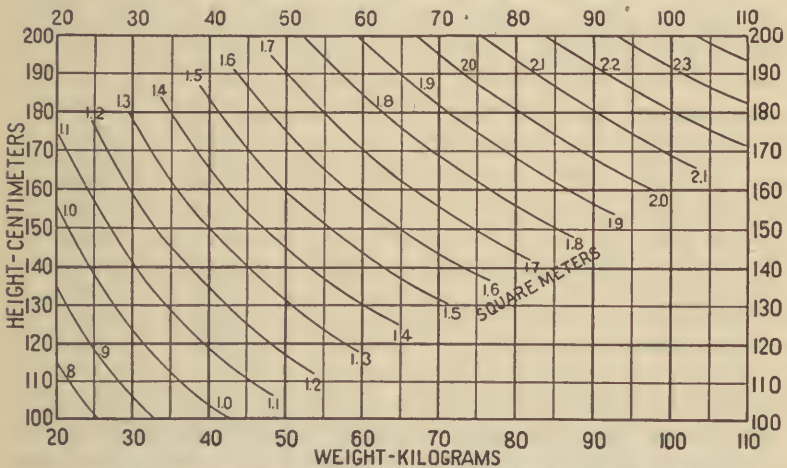
Chart for determining surface area of man in square meters from weight in kilograms (Wt.) and height in centimeters (Ht.) according to the formula: Area (Sq. Cm.) = Wt.° ⁴²⁵ × Ht.° ⁷²⁵ × 71.84.

TABLE No. 1.

Conversion Table for Use with Above Chart.

200	Centimeters	= 80	in.	or 6.66 ft.	20	Kilograms	= 44	lbs.
190	"	= 76	"	or 6.33 "	30	"	= 66	"
180	"	= 72	"	or 6.00 "	40	"	= 88	"
170	"	= 68	"	or 5.66 "	50	"	= 110	"
160	"	= 64	"	or 5.33 "	60	"	= 132	"
150	"	= 60	"	or 5.00 "	70	"	= 154	"
140	"	= 56	"	or 4.66 "	80	"	= 176	"
130	"	= 52	"	or 4.33· "	90	"	= 198	"
120	"	= 48	"	or 4.00 "	100	"	= 220	"
110	"	= 44	"	or 3.66 "	110	"	= 242	"
100	"	= 40	"	or 3.33 "				

dividual, the height and weight being known. The result is stated in square meters, and comparisons between individuals are commonly referred to a one square meter standard. Basal metabolism estimations have shown that a fasting (12 to 14 hours) and resting adult of middle age requires very considerably less oxygen and hence expends less energy* for the same area of body surface than a child or youth, or even young adult. The greater metabolic activity in early life is in part due to the fact that growth is taking place at that time, in part that metabolism is on a higher level. These differences in terms of calories per square meter per hour are shown in the accompanying table (Table 2) from Aub and DuBois.

TABLE No. 2.†

Normal Standards. Figures for females calculated as seven per cent. below the average for males. Calories per square meter of body surface per hour (Height-Weight Formula).

Age in years	Male	Female
14 to 16	46.0	43.0
16 to 18	43.0	40.0
18 to 20	41.0	38.0
20 to 30	39.5	37.0
30 to 40	39.5	36.5
40 to 50	38.5	36.0
50 to 60	37.5	35.0
60 to 70	36.5	34.0
70 to 80	35.5	33.0

Calculation of Caloric Needs. In middle life a high level of basal metabolism may exist as a result of hyperthyroidism (*e.g.,* in Graves's disease) and to a less extent in certain infections, such as tuberculosis; a low level in myxedema and conditions of subnutrition.

In determining the proper energy requirements for a given adult it is first necessary to calculate the basal requirements and then to add the necessary increments necessitated by digestion, absorption and elimination of food ("specific dynamic factor"), by restricted activity, by light work, moderately heavy work, or severe work. It will be found that the requirements of normal

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* If we assume a respiratory quotient of 8.2, one liter of O_2 corresponds to 4.825 calories.

† Basal Metabolism of Old Men, 19th Paper. J. C. Aub and E. F. DuBois, Arch. Int. Med., xix, 823, 1917.

men in the same age period, whether tall or short, emaciated or obese, indolent or active, are basically almost identical when the above mentioned considerations are taken into account and the results are reduced to a uniform unit of body surface.   The slightly lower metabolic rate in women (7 per cent.) is attributed to the greater proportion of subcutaneous fat, which is metabolically an inactive tissue, and at the same time a good conserver of body heat.   It is convenient to take average individuals with a body surface in the case of the male of 1.8 square meters, and in the female of 1.63 square meters, for purposes of illustration and comparison.   These measurements correspond to hypothetical individuals of 154 pounds (70 kilograms) weight, and 5 feet 8 inches (170 centimeters) height, and 132 pounds (60 kilograms) weight, and 5 feet 4 inches (160 centimeters) height respectively, for men and women.   Tables 3 and 4 on following page illustrate the method of computation.

In these tables slightly less than ten per cent. is apparently allowed for rest *with food* ("hospital ward").   Extra calories are added for eight hours out of twenty-four.   The following data are quoted by the same authors (*l.c.*, p. 71) from Lusk: Man in bed twenty-four hours without food—1680 calories; with food—1840; with light work in chair sixteen hours—2170; in bed eight hours, chair fourteen hours, moderate exercise two hours—2500 calories.   According to Gephart and DuBois,[1] men and women between forty and fifty require 4.3 per cent., and between fifty and sixty, 11.3 per cent. less than the average for adults between twenty and fifty.   Taking the latter figure as typical for the age we are considering, a deduction of two hundred calories should be made from the figures in the table (No. 3) for men, and of one hundred and sixty (No. 4) for women.   Thus, a tailor, and similarly a clerk or physician, would require 2040 calories; a typist, or woman similarly employed, 1610 calories. The basal metabolism calculated according to Table 2 for a man of sixty years, measuring 1.8 meters, would be 1577, or with food 10 per cent. additional or 1735, corresponding to 1900 (1900—200=1700) in the above table.

Of late the caloric method of expressing food values has somewhat fallen into disrepute. This is partly a reaction from the exaggerated emphasis formerly given to the method, to the exclusion of older ideas in reference to the proper balance of the principal

TABLE No. 3.

Extra calories per hour attributable to occupation and total daily metabolism for various occupations. (Modified from Lusk.) *

Occupations of Men	Extra Calories per Hour.	Total daily Metabolism. Average man 5 ft. 8 in. and 155 lbs.
Basal		1770
Hospital ward		1900
Tailor	44	2240
Bookbinder	81	2530
Shoemaker	90	2600
Metal worker, filing and hammering	141	3000
Painter of furniture	145	3050
Carpenter making table	164	3200
Stonemason chiseling tombstone	300	4300
Man sawing wood	378	4900

TABLE No. 4.

Occupations of Women	Extra Calories per Hour.	Total daily Metabolism. Average woman 5 ft. 4½ in. and 134 lbs.
Basal		1480
Hospital ward		1580
Seamstress, needlework	6	1630
Typist, 50 words per minute	24	1770
Bookbinder	57	2030
Seamstress using sewing machine	63	2080
Housemaid, moderate work	81	2220
Laundress, moderate work	124	2560
Housemaid, hard work	157	2830
Laundress, hard work	214	3490

foodstuffs. It was only the discovery of the vital differences in various proteins, the essential character of minute amounts of accessory food substances and the full significance of mineral salts that recently swung the pendulum in the opposite direction. Nevertheless, calories remain the most convenient units for expressing food, or more precisely energy values. In the present chapter it will not be necessary to go into more detailed explanations, as the basic principles of energy exchange have in recent years become common property and are adequately dealt with in standard works on dietetics.

* Nutrition and Clinical Dietetics, Carter, Howe and Mason, Phila., 1921, p. 72.

The Essential Foodstuffs. *Protein.* The essential food-stuffs are the same at all ages, but their proper quantitative distribution is subject to considerable variation; the optimum for any given foodstuff is not the same in middle life as at an earlier period. The foodstuffs proper, the energy yielders, are proteins, fats and carbohydrates. No less essential, however, are mineral salts, accessory food substances (vitamins), oxygen and water. Of the three foodstuffs, the most essential is protein, since it alone can serve for the repair of the tissues. The absolute amount required is, however, relatively small. Hinhede[2] has recently made the statement that the protein minimum is so low for man that it cannot be reached, provided sufficient calories are furnished. The latter is an important reservation since famine dropsy has been observed to develop when protein and calories are both unduly reduced, below 50 grams and 1200 calories respectively.[3] Sherman[4] has compiled all the dependable cases, in which with an adequate caloric intake, a barely sufficient amount of protein has been allowed. In a study of 109 experiments comprising both men and women a minimum requirement of 44.49 grams of protein for the average individual of 154 pounds (70 kilograms) was calculated. These figures are even lower than those proposed by Chittenden as the result of his studies on "Economy in Nutrition," and are approximately one-third of the traditional standards (Voit, 118 grams; Atwater, 125 grams).

While such a low intake of protein may be consistent with the maintenance of health, and hence justifiable under conditions of food stringency, or in the presence of severe impairment of the kidney function, etc., it is not ordinarily advisable, since it is unnecessary, and at the same time affords no reserve. Conservative opinion recognizes an allowance of from seventy-five to one hundred grams as most suitable for the average adult, a liberal ration being particularly necessary when there is any question as to the quality of the proteins furnished. Formerly proteins, irrespective of their source, were regarded as essentially identical in nutritive value. Gelatin, on the contrary, though closely resembling protein, was known to be lacking in certain amino acids and hence inadequate to replace protein in the diet. The chemical and feeding experiments conducted by American observers: McCollum, Mendel, Osborne and others, have shown that many proteins, particularly those derived from the principal cereals,

are similarly, though to a less degree, incomplete. As an ex-
clusive source of protein, these substances fail to promote growth,
and in the long run to maintain nutrition or even life itself. In
general, vegetable proteins are inferior to animal proteins, and it
requires considerable skill and experience to arrange a dietary
with the optimal quantities of the various amino acids, if foods
of animal origin are altogether excluded. A very moderate
amount of milk or milk products, with or without eggs, is suf-
ficient to correct such deficiencies in a diet otherwise purely vege-
tarian (lacto-vegetarian diet of French authors). We may, there-
fore, amplify Hinhede's statement with the reservation that no
ordinary diet of sufficient caloric value, which contains even a
small proportion of milk products, eggs, or meat, is likely to be
deficient in protein. Middle aged persons with a family tendency
to gouty disorders, cardiovascular or renal diseases will do well
to restrict their protein intake (seventy-five grams or thereabout) ;
ordinary persons devoid of such tendencies will probably derive no
advantage from limiting themselves so closely. The old idea that
protein is the most valuable source of muscular energy has long
since been refuted. This function is better subserved by fats and
carbohydrates. On the other hand protein is known to raise the
level of metabolism (specific dynamic action). This has been held
by some to be advantageous, since the most progressive races in
the world are meat eaters. It is now generally agreed that ten to
fifteen per cent. of the total calories should be furnished by pro-
tein. The percentage of protein should vary inversely with the
total number of calories. Our hypothetical individual of 1.8
square meters body surface, 154 pounds of weight, engaged in a
light occupation (*e.g.,* a shoemaker) may derive 240 to 360 (300)
of his total of 2400 calories from protein (60 to 90 grams).

Fats. Granted that a liberal allowance of protein for main-
tenance has been supplied, the remaining calories—2100 in our
hypothetical case—are preferably, though not necessarily, supplied
by fats and carbohydrates. Under extreme conditions the neces-
sary calories may be furnished almost entirely from either source.
Thus Arctic explorers have been accustomed to live on pemican
which consists almost entirely of fat and protein (Stefansson
lived on fresh meat alone), while the denizens of the tropics
subsist on a diet which consists largely of starch (rice). In
the temperate regions experience has shown that an allotment of

fifty to one hundred and fifty grams of fat gives the most satis-
factory results, the palatability of the diet varying, more or less
directly with the proportion of fat. One hundred grams of fat
will yield approximately nine hundred calories. This, with the
three hundred calories furnished by protein, will supply one-half
of the necessary calories in our illustrative case.

For a quarter of a century physicians have been insisting that
the quantity and not the quality of the fat is the main considera-
tion; hence olive oil, vegetable oils, lard and oleomargerine have
been considered in all respects equal to codliver oil, cream and
butter. The investigations of the last decade, however, entirely
vindicate the reputation which the last named substances have
held through generations, so that now the importance of cream
and butter fat, particularly for the growing organism, is fully
recognized. Even in middle life a total lack of these substances
is likely to lead to deficiency diseases. As will be seen later,
however, the superiority of codliver oil and butter fat is quite in-
dependent of their functions as sources of energy. The preëmin-
ence of butter fat is due to associated substances known as vitamins
(particularly fat-soluble A); which in turn are dependent on the
diet of the milch cattle (green fodder).

Carbohydrates—Starches and Sugars. The quality of carbohy-
drates is not entirely indifferent, though many of the characteris-
tics which lead us to give the preference to one rather than to
another, are due, as in the case of the fats, to accidental factors,
and not to intrinsic differences, as in the case of proteins. These
accidental or associated substances, such as vitamins, mineral
salts, proteins and "ballast," are considered separately. Carbohy-
drates are of two general classes, starches and sugars. The
greater bulk of the daily requirements should consist of starches.
An excess of sugar is a potential source of danger at this period
of life, when obesity and diabetes are particularly prone to develop.
Some authorities have even attributed gout, and more recently
rheumatoid arthritis, to an excess of carbonaceous materials (fats
and carbohydrates) rather than to any type of protein food. The
major part of the carbohydrate ration will be derived from cereal
foods and roots, but as considerable an amount as practicable
should be taken in the form of fruits and green vegetables. A
total of three hundred grams of carbohydrates will be necessary
to supply the one thousand two hundred calories which will be re-

quired in the specific case we have been using for illustration. Any further demands for energy should be supplied from the same source; the quantity of fats and proteins being unchanged or only moderately increased. This is an important point and one that should be strongly emphasized, since the old idea that the worker requires a supply of meat proportionate to the severity of his occupation is still current among the laity.

Mineral Elements. The principal mineral elements are sodium, potassium, calcium, iron, phosphorus, chlorine, etc. Milk is the principal source of calcium salts; potassium salts are found in liberal amounts in green vegetables; iron is derived largely from meats and leafy vegetables; phosphorus from the glandular organs. Any diet which includes a reasonable amount of green vegetables, eggs, milk, and meat is certain to contain a sufficiency of these substances. Iodine, of which minute amounts are essential for the proper functioning of the thyroid, seems to be lacking in the diet or waters of certain districts. Marine and Kimball[5] have successfully supplied this lack by the internal administration of small doses of iodides. In pregnant women and nursing mothers, an excess of calcium salts is necessary and should be supplied in the form of milk, buttermilk, or cheese, thus protecting the teeth and other calcium containing tissues from deterioration.

Accessory Food Substances. The imagination of the public has of late been caught by the newly discovered accessory food substances, commonly known as vitamins, which even in minute amounts exercise a pronounced influence on growth and nutrition, and the lack of which leads to a train of deprivation diseases. Beriberi, starvation edema, xerophthalmia, scurvy and less definitely, pellagra, rickets, general malnutrition and some chronic diarrheal diseases are examples of such affections. Many of the deprivation diseases have enjoyed an evil prominence in the last seven years as a result of war conditions. Under circumstances of plenty, such as prevail in the United States, there seems to be little excuse for the presence of these diseases among adults at the age period under consideration. Nevertheless, in certain regions of the South, as well as in prisons and other public institutions, monotonous and badly balanced diets, whether chosen by necessity or through ignorance, have led to a wide prevalence of pellagra, and to a less degree of scurvy. Undoubtedly there is

a larger group of persons, who as a result of faulty diet, exhibit a certain degree of malnutrition which may reasonably be assigned to a lack of vitamins. In occasional instances deficiency diseases may even develop in well-to-do persons, consequent upon personal idiosyncrasies or dietetic fads.

Three well defined vitamins are definitely known at the present time: Vitamin A, otherwise known as fat-soluble A, the lack of which leads to defects of growth and nutrition, and in children, to the condition known as xerophthalmia; Vitamin B, the antineuritic or water-soluble vitamin, the lack of which causes beriberi; and Vitamin C, the anti-scorbutic vitamin. McCollum[5a] has recently suggested the existence of a fourth vitamin, which plays a rôle in bone growth. Vedder[6] has formulated excellent dietary rules for the prevention of deficiency diseases in institutions. These provide for the frequent use of fresh fruit, green vegetables, potatoes, dried beans or bran, and fresh meat. The too exclusive use of canned goods must be avoided. Where cereals constitute the staple article of diet, whole wheat flour, undermilled rice or water-ground corn meal should be used. (To this list which is simplified as much as possible for economic reasons, should ordinarily be added milk and butter. C.B.F.) He believes that the strict application of his rules will eradicate scurvy, beriberi and pellagra from the United States and its possessions. Goldberger[7] voices a similar opinion, as follows: "For practical purposes of preventive medicine it would seem to be of fundamental importance to recognize that the pellagra producing dietary fault, whatever its intimate nature or however brought about, is capable of correction or prevention by including in the diet suitable proportions of fresh animal and leguminous protein food."

Ballast. A diet must not only be correct in the amount and quality of its principal constituents, but must also be of suitable physical form. For the healthy adult of middle age, with well preserved or well repaired teeth, it should not be too refined in form or consistency and should contain a liberal amount of indigestible material, commonly spoken of as roughage or ballast. Ballast consists principally of cellulose which is found richly in the incompletely milled cereals, in green vegetables, in coarse roots, in fruits and berries. The principal function of the indigestible residue is to act as a mechanical stimulus to the intes-

DISTRIBUTION OF THE THREE VITAMINS IN THE COMMON FOOD STUFFS.*

Classes of foodstuff	Fat-soluble A or antirachitic factor	Water-soluble B or antineuritic (antiberiberi) factor	Antiscorbutic factor
Fats and Oils:			
Butter	+ + +		
Cream	+ +		
Cod-liver oil	+ + +		
Mutton fat	+ +		
Beef fat or suet	+ +		
Peanut oil	+		
Fish oil, whale oil, etc....	+ +		
Margarin prepared from animal fat	Value in proportion to amount of animal fat contained		
Nut butters	+		
Meat, Fish, etc.:			
Lean meat (beef, mutton, etc.)	+	+	+
Liver	+ +	+ +	+
Kidneys	+ +	+	
Heart	+ +	+	
Brain	+	+ +	
Sweetbreads	+	+ +	
Fish, white	....	very slight, if any	
Fish, fat (salmon, herring, etc.)	+ +	very slight, if any	
Fish, roe	+	+ +	
Canned meats	?	very slight	
Milk, Cheese, etc :			
Milk, cow's whole, raw	+ +	+	+
Milk, skim raw	....	+	+
Milk, dried whole	less than + +	+	less than +
Milk, boiled, whole	undetermined	+	less than +
Milk, condensed, sweetened	+	+	less than +
Cheese, whole milk	+		
Eggs:			
Fresh	+ +	+ + +	?
Dried	+ +	+ + +	?
Cereals, Pulses, etc.:			
Wheat, maize, rice, whole grain	+	+	
Wheat germ	+ +	+ + +	
Wheat, maize, bran	....	+ +	

Classes of foodstuff	Fat-soluble A or antirachitic factor	Water-soluble B or antineuritic (antiberiberi) factor	Antiscorbutic factor
Cereals, Pulses, etc. (continued).			
Linseed, millet	+ +	+ +	
Dried peas, lentils, etc......	....	+ +	
Soy beans, haricot beans ..	+	+ +	
Germinated pulses or cereals	+	+ +	+ +
Vegetables and Fruits:			
Cabbage, fresh (raw)	+ +	+	+ + +
Cabbage, fresh (cooked) .	....	+	+
Cabbage, dried	+	+	very slight
Cabbage, canned	....	....	very slight
Swede (rutabaga) raw, expressed juice	....	....	+ + +
Lettuce	+ +	+	
Spinach (dried)	+ +	+	
Carrots, fresh raw	+	+	+
Carrots, dried	very slight		
Beetroot, raw, expressed juice	....	....	less than +
Potatoes, raw	+	+	
Potatoes, cooked	....	....	+
Beans, fresh, scarlet runners, raw	....	....	+ +
Onions, cooked	....	....	+ at least
Lemon juice, fresh	....	....	+ + +
Lemon juice, preserved ...	....	....	+ +
Lime juice, fresh	....	....	+ +
Lime juice, preserved	....	....	very slight
Orange juice, fresh	....	....	+ + +
Raspberries	....	....	+ +
Apples	....	....	+
Bananas	+	+	very slight
Tomatoes (canned)	....	....	+ +
Nuts	+	+ +	
Miscellaneous:			
Yeast, dried	....	+ + +	
Yeast, extract and autolysed	?	+ + +	
Malt extract	....	+ in some specimens	

None of the three factors were found in:
Lard.
Olive, cottonseed, coconut or linseed oils.
Coco butter.
Hardened fats, animal or vegetable in origin.
Margarin from vegetable fats or lard.
Cheese from skim milk.
Polished rice, white wheaten flour, pure cornflour, etc.
Custard powders, egg substitutes, prepared from cereal products.
Peaflour (kilned).
Meat extract.
Beer.

tinal tract, assuring a prompt emptying of the colon and rectum. Fruit acids, vegetable oils, sugars and condiments are useful natural adjuvants. Persons who for one reason or another cannot take a sufficient amount of roughage, or require additional stimulation, may be given prepared bran or agar-agar, substances which are hardly more than dietetic. Persons with defective teeth or delicate digestion require a different type of diet such as that suggested by Rose (see below). For the correction of constipation the latter class will depend on the natural adjuvants above mentioned and vegetable purées.

Water. Water is much more liberally used by Americans than by other peoples, and this free use has been shown by Hawk to be valuable in promoting absorption and elimination, and in no way unfavorable to digestion, even when taken with meals. This is quite at variance with the customs of Europe, where the free use of water is frequently tabooed, except in the course of definite "cures." The prophylactic value of a free use of water, mineralized, or otherwise, in certain affections of middle life, such as gout, renal and biliary calculi, etc., is generally admitted. On the other hand, myocardial weakness is a definite contra-indication to the ingestion of excessive amounts of water, which may overburden the heart, or even induce acute dilatation. I recollect at least one case in which a "water cure" was followed by acute dilatation of the heart, with accompanying cyanosis. In this patient very free bleeding promptly restored the circulatory balance. Similar contra-indications exist in cases in which there is a tendency to atony of the stomach, not to speak of more definite pathological conditions which lie beyond the scope of this article.

Digestibility. The relative digestibility of various foods is as often as not a question of preparation and to this extent deserves the careful consideration of healthy adults. Greasy foods, insufficiently cooked vegetables and cereals, heavy breads and pastries, as well as excessive quantities of certain raw vegetables, radishes, cucumbers, etc., are obviously a burden to the healthy stomach.

Hawk,[8] *et al.*, on the other hand state that "in general raw vegetables . . . as carrots, celery, tomatoes, cabbage, lettuce and cucumbers, leave the stomach rapidly . . . without great change."

Granted that food is well prepared and well masticated, its usefulness in any given case will be determined by the principles already laid down, or those yet to be considered. The usual standards of digestibility refer in the main to the time required for the emptying of the stomach and the degree of gastric secretory response. Penzoldt[9] made many careful observations and determined the evacuation time of definite amounts of a large variety of foods. On the basis of his investigations he constructed tables of relative digestibility which are of particular value in outlining the dietetic treatment of gastric ulcer. Recently Hawk[10], Rehfuss and their co-workers have published an extensive series of observations carried out by means of fractional extractions, which not only determine the influence of a great variety of foods on motility, but also shows their influences on the secretory curve. These should be of great value in the construction of dietaries for use in functional and organic diseases of the stomach, or for normal persons with limited digestive capacity. They have less bearing on the ordinary case, since digestion is to be regarded as a function of the whole gastro-intestinal tract, and not of the stomach alone. The ability of the intestine to deal with various types of foods can only be roughly guessed by inspection of the stool and by the presence or absence of colic, flatulence and diarrhea. Experience teaches that cabbage, beans, green corn, raw vegetables and fruits are most liable to disagree.

Bacterial Flora of Intestines—Autointoxication. The normal bacterial flora of the gastro-intestinal tract may be modified, favorably or unfavorably, by diet. The fermentative type of organisms becomes dominant if the diet is overrich in sugars and starches; the putrefactive, if meat predominates. One of the ways in which a cellulose rich diet (ballast) aids constipation is by inducing fermentation. The products of the latter process stimulate peristalsis. Excessive fermentation on the other hand is likely to prove harmful in myocardial weakness and atonic states of the stomach and intestines. The gases which are formed distend the stomach and may mechanically embarrass the heart. Hence diets rich in coarse vegetables are to be avoided if there is good reason to suspect the presence of the above mentioned conditions (see Arteriosclerosis Diet). Many authorities—Bouchard, Combes, Arbuthnot Lane, etc., have attributed a host of symp-

toms: headache, dizziness, mental depression, muscæ volitantes,
dyspepsia, etc., to so-called "intestinal autointoxication." The
production of the "toxins" is favored by a pabulum suited to the
particular type of organism and as a rule by conditions of stasis,
less often by diarrhea.   Implantation of competing organisms, a
restricted or one sided diet (usually vegetarian) and intestinal
resections are among the measures advocated for the correction of
the difficulty.   Metchnikoff at one time thought that arteriosclero-
sis and other evidences of old age were induced by subtle poisons
absorbed from the intestines and advocated the administration of
lactic acid bacilli as an effectual means of combating putre-
factive bacteria and prolonging life.   He was influenced, no doubt,
in his opinions by the reputed longevity of the inhabitants of the
steppes (who use kumyss) and of the Bulgarian peasants (who
prepare a special type of buttermilk).   We are indebted to this
school for a much freer general use of vegetables and of casein,
the latter a valuable and "complete" protein.   While the "auto-
intoxication" hypothesis still enjoys a wide popularity, largely
owing to its seeming plausibility, it has not been generally accepted
by scientific physicians.   Alvares[11] disposes of it as follows:
"Auto-intoxication is commonly diagnosed when a physical ex-
amination would show other more definite causes for the symp-
toms.   Those who believe that intestinal stasis can account for a
long list of disease conditions have little proof to offer for their
views.   Many of the assumptions on which they rest their case
have been proved to be wrong."

"The usual symptoms of the constipated disappear so promptly
after a bowel movement that they cannot be due to absorbed
toxins.   They must be produced mechanically by distention and
irritation of the colon.   They occur in nervous, sensitive people.
It has been shown that various activities of the digestive tract can
profoundly affect the sensorium and the vasomotor nerves.   The
old ideas of insidious poisoning lead to the formation of hypo-
chondriacs: the new explanation helps to cure many of them."

Effect of Age and Sex. As the general principles of nutrition
have already been discussed somewhat at length, many of the
modifications which are proper for individual cases have already
been alluded to, and will only need to be recapitulated.   Age is
of some moment, since the energy requirements of men and
women between forty and fifty is 4.3 per cent., and of those be-

tween fifty and sixty 11.3 per cent., below the general average of adults. Thus a man who requires thirty-eight basal calories per square meter per hour at the age of forty-five, will only need thirty-five at the age of fifty-five. The lower caloric requirements of women have already been referred to; they seem to be due to peculiarities of physical conformation rather than to purely sexual factors. Menstruation does not appreciably alter caloric requirements, and pregnancy except in the later stages only to a surprisingly small extent. During lactation there is a very definite increase in metabolism which bears a very close relation to the amount of milk secreted. According to the best authorities diet has little effect upon the general chemical composition of milk, but as in the case of cattle, the vitamin content is largely influenced by the character of the diet, being increased, *e.g.*, by suitable amounts of leafy vegetables. A very moderate increase in the diet, preferably in the form of milk, is sufficient to supply the extra nutrition and is preferable to the indiscriminate stuffing which so often leads to obesity. Under ordinary conditions the mother's nutrition will suffer before the quality of the milk as regards protein, fat and sugar, is impaired. Coincidentally with the menopause, though perhaps not because of it, since a similar tendency is seen in men, the energy requirements are diminished and there is a tendency to put on weight.

Other Factors which Modify Dietetic Requirements. Persons of varying physical type apparently consume very different amounts and qualities of food. Thus, persons of the sthenic habitus—short neck, broad shoulders, deep chest, broad epigastric angle, short wide roomy abdomen and plentiful deposit of fat often seem to eat less proportionately to their bulk, than those of the opposite, or asthenic type—long neck, sloping shoulders, narrow chest, acute epigastric angle, long flat abdomen and inclined to spareness. When, however, the body surface as determined by the height-weight formula, is taken into consideration this apparent disparity disappears. It is then evident that the thin lanky type has a disproportionately large radiating surface. The majority of individuals, however, belong to the normal or intermediate type.

Observations with the fluoroscope show that these long recognized types are correlated with corresponding peculiarities in the gastro-intestinal tract. The sthenic or hyper-sthenic habitus is

ordinarily associated with a "steerhorn" type of stomach and a colon corresponding in its form to classical anatomic plates. The hyposthenic, or asthenic habitus is associated with a ptosed, "fish hook" stomach and with a peculiarly disposed large intestine. The cecum is generally abnormally low and the transverse colon loops well down toward the pelvis. The visceral conformation peculiar to the asthenic type predisposes to disturbances of motility and entails a consequent modification of diet, often instinctive. Bryant has renamed the sthenic and asthenic types, herbivorous and carnivorous, respectively. The first named type possesses in addition to the peculiarities already noted, an elongated intestine (small) and is adapted to a diet largely vegetarian in nature. Persons of this type are inclined to obesity. The carnivorous type has difficulty in digesting coarse bulky diet and fares best on a concentrated diet, largely animal in origin. Individuals belonging to this group are thin, often emaciated, and commonly constipated. Whether these theories can be substantiated in detail is doubtful, but they would seem to afford us useful hints in arranging diets for healthy though aberrant types of adults.

Another old fashioned point of view had reference to the constitution or habit of a patient. This expressed an inherent or acquired tendency to disease. It was customary to speak of the gouty habit, the nervous constitution, etc. The person of the gouty habit is florid, thin skinned, inclined to skin eruptions, joint disease, obesity, etc. He is especially intolerant of excess whether of alcoholics, foods or sugars. The patient of the nervous habitus is inclined to be too dependent on stimulants such as coffee and tobacco, and to suffer from functional digestive disturbances. There are other hereditary and personal tendencies to disease which are not included in the conventional "habits," which should, nevertheless, be born in mind. Of these the most important is idiosyncrasy or sensitization to certain foods. In susceptible individuals particular articles of food are liable to bring on attacks of urticaria, eczema, asthma, etc. Where such a condition is suspected, skin tests with purified proteins, which Walker has done so much to popularize, should be employed to detect the offending food, unless the latter is already known. Unfortunately in middle life the susceptibility to foods is likely to be less sharply defined than in childhood, so that results of this particular type of investigation and treatment are frequently disappointing.

Dangers of Hypernutrition. While the value of specific restrictions is frequently debatable, the dangers of hypernutrition are very real at this stage of life. In youth and adolescence the satisfaction of a hearty appetite very seldom leads to deleterious results. The growing organism can make use of surprisingly large amounts of food. This is the reason that young boys often eat as much or more than adults almost double their weight. In middle life the demands of growth are slight and for persons in the leisure classes, unless they are athletically inclined, the energy requirements are also small. These are exactly the persons who are most exposed to the dangers of a too liberal table. The most indisputable advice that can be given to persons of this sort is to limit their diet, so that their weight does not exceed the average for their age and height; or better still for their height and weight at maturity (thirty years). The tables employed by Insurance Companies tend to exaggerate the weights appropriate to the several ages and the optimum is rather below than above the average figures given.* Bornhardt's formula is said by Gray and Mayall[12] to give the most accurate estimate of the proper weight: "If H be the height without heels in centimeters, C the mean chest girth in centimeters as measured over the nipples, W the net weight in kilograms, then the expected weight for the adult of average constitution is: $W = H \times C/240$."

In some of the countries involved in the late war, diet restrictions seem to have been rather beneficial than otherwise in diminishing the incidence of obesity and allied disorders. Joslin has recently laid stress on the fact that the obese person is potentially a diabetic and has formulated the following diabetic law. "It is rare for diabetes to develop in an individual above the age of twenty years who is habitually underweight, and when it does develop the case will usually be found to be either extremely severe, extremely mild, or associated with a marked hereditary taint or degenerative stigmas." The causative relation of gout to hypernutrition and alcoholism, and its frequent association with obesity and diabetes, is so well known as to be trite. In persons inclined to overweight or with a family tendency to obesity, gout or diabetes, it seems reasonable to insist on a timely restriction of proteins and carbohydrates. The figure of 75 grams has al-

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* NOTE—For table see Rose, *l. c.*, p. 429, 430 (Symonds tables) or Da Costa, Handbook Med. Treat., Phila., i, 479-481, 1918.

ready been suggested for protein which means a small serving of meat and one egg a day, in addition to the usual vegetable food. As regards carbohydrates—sweets and sugars (candy, cakes, ices, soft drinks, etc.) should be particularly avoided. The author has given detailed diets for gout, obesity, diabetes, etc., in his article in Da Costa's Handbook of Medical Treatment (Vol. I, pp. 449-541, Davis, Phila., 1918). In a later section of this chapter less elaborate restrictions suitable to the present purpose will be outlined.

The value and popularity of fasting in the control of diabetes lends interest to the following: Folin and Dennis[13] suggest that a perfectly safe, rapid and effective method of reducing the weight of very obese persons is by a series of repeated fasts ot increasing duration, the ammonia or beta-oxybutyric acid determination being used as a guide to the length of each fast. They found that while acetone bodies appeared within a few days after the beginning of the first fast, after the second, third and subsequent fasts the onset of acidosis was gradually deferred. Feeding periods were interposed between fasts. They believe that one of the effects of repeated fastings is habituation to the complete oxidation of mobilized body fat, and a consequent retardation of the development of acidosis.[13] As far as I am aware the method described has not been used to any extent clinically. Fasting, however, is too severe a form of treatment for the slight deviations from the normal, transient glycosuria and slight degrees of overweight or plumpness, which we are considering. It is important, moreover, to remember that fasting is not a method for self treatment—in fact should not be used without careful control.

Subnutrition. Subnutrition may be of a general character or may belong to one of the special types already considered—scurvy, beriberi, pellagra. Since this chapter does not deal primarily with disease we need not discuss these special types further. Other pathological types of subnutrition are dependent on disorders of the endocrin glands (thyroids, adrenals) or more commonly on latent or incipient infection—most often tuberculosis. In the last named cases it is sometimes difficult to determine whether infection is already present or not. Fortunately hyperalimentation in combination with rest and fresh air is both of prophylactic and curative value. At the present time we do not push forced feeding to the extent formerly advocated, but an endeavor should be made to attain a weight appropriate to the

individual as determined by Bornhardt's formula (*q.v.*). In the selection of a diet for such a case due attention should be given to a supply of vitamins (Table 4) and of high quality proteins (meat, fish, eggs, milk and cottage cheese), as well as to the total caloric value. Milk and eggs are the simplest and most easily calculated additions, but the patient's tastes and not the physician's convenience should be considered.

Many persons with chronic subnutrition, whether tuberculous or not, are of the asthenic or carnivorous type. On account of the disposition of the gastro-intestinal canal in these persons (gastroptosis and coloptosis) coarse bulky foods and large meals are not well tolerated. A concentrated diet, moderately rich in protein and fat, and frequent meals, are most suitable. The vegetable components, including lettuce, celery, spinach, peas, etc., should be finely divided by chopping, mashing or sieving (purée form), as well as by careful mastication. Rest, after the principal repast at least, is strongly indicated as this facilitates the emptying of the stomach. We will not discuss here the aggravated cases which require a full "rest cure." Many persons of this habitus, probably because of chronic dyspeptic disturbances, live on restricted and ill balanced diets or follow popular dietetic fads. They may go without breakfast or follow a pure vegetarian diet. Occasionally sthenic or normal persons, fearing obesity, may follow a similar course; in either case a low level of metabolism may be reached and maintained. In this condition a person may show a low nitrogen balance and subsist after a fashion on a minimum caloric intake. A patient of mine in whom restrictions were necessitated by achylia gastrica subsisted for many years in comparative health on a diet which did not much exceed 1000 calories. In the Orient, and at the present time in Eastern Europe millions of people live on a similarly low level of nutrition. Though such a state may appeal to ascetics and dietetic cranks, it is not conducive to the highest mental and physical accomplishment, and makes the person liable to intercurrent infections, arthritis, anemia, deficiency diseases, etc., even if he is spared the danger of gout and diabetes.

The experience of Denmark during the war has shown that the nutrition of the general population may be improved where an adequate diet is insured by government regulation, instead of being left to personal taste, economic necessity or commercial interest.

The Place of Alcohol in the Dietary—Other Beverages.
When we come to speak of alcohol, coffee, tea and cocoa as
factors in the diet of persons of middle age, we enter upon a
domain of controversy. One might be justified in ignoring alco-
hol altogether in view of recent legal enactments; particularly as
we are concerned solely with its dietetic use. Alcohol is now
universally recognized to be a narcotic and not a stimulant. In the
moderate amounts in which it is used in many countries, mainly
"Latin," as an accessory to food, its narcotic quality is not mani-
fest, or only to a degree which softens the asperities of life.
Taken in amounts not exceeding one or two ounces, corresponding
to the usual one-half bottle of wine or mug of beer it may be com-
pletely burned up and furnish a not inconsiderable quota of energy
(200 to 400 calories) since its caloric value corresponds to seven
calories per gram. The chief argument in its favor is that it
renders the monotonous and often unattractive diet of the Euro-
pean peasant or workman more palatable. When taken with
foods in moderate quantities it does not cause local irritation of
the gastric mucosa. Similar quantities of more concentrated
beverages, such as whisky or cocktails, taken before meals have
little to be said in their favor, as they not only stimulate the ap-
petite and induce excess in eating, but in the long run may initiate
serious local inflammatory changes. Whiskey, taken on the
empty stomach, particularly before breakfast is a most prolific
cause of chronic gastritis and cirrhosis of the liver. The opera-
tion of the Prohibition Amendment will, in time, probably make
these disorders among the rarities of medicine. Gout is another
affection which, as above stated, is largely dependent for its exist-
ence on alcohol, in the form of fortified wines and malt liquors.
It is an old saying that wine is the "milk of the aged" and this
has perhaps been extended to include the period of life with
which we are dealing. While a small amount of wine is well
borne by people in advanced life, particularly if they have been
habituated to it, they are by no means immune to its harmful
effects. This point has been stressed by French observers (*e.g.,*
Boy—Teissier[14]), who cannot be accused of being prejudiced in
favor of teetotalism. In certain diseases of middle life, particu-
larly in diabetes, alcohol (whiskey) may serve a useful purpose
in supplementing extremely restricted diets, though even here its
use is not essential. However much may be said in favor of the

moderate use of alcohol in connection with meals it must be admitted that it has never formed an important part of the native American dietary, so that in this country the evils of its excessive use have greatly overbalanced any possible dietetic advantages which it may have possessed. The illicit use of immature whiskey ("moonshine"), "raisin jack," preparations containing denatured alcohol, and similar concoctions is undoubtedly more dangerous than the use of well aged whiskey, but fortunately it is restricted to comparatively few persons.

Coffee, tea and chocolate are employed in this country with a relative frequency corresponding to the sequence given, though curiously enough the order in which they were introduced as common beverages was just the reverse. They all contain alkaloids of similar nature, but in cocoa and chocolate the characteristic theobromin is so small in quantity and so mild in action that it need not be taken into consideration in persons of middle age. Cocoa and chocolate are chiefly valuable as giving a pleasant flavor to milk, and encouraging its use as a beverage. Tea and coffee both contain caffein, but the cup of coffee as ordinarily prepared contains approximately twice as much (2 grains) of the alkaloid as the corresponding amount of tea (1 to 1½ grains). Tea is likely to be deleterious because of prolonged steeping which, while it does not materially increase the amount of caffein, more than doubles the quanity of tannin. This tends to irritate the stomach and it aggravates constipation. The deleterious effects of coffee are more directly due to caffein, which is a powerful cardiac and renal, as well as cerebral stimulant. Its excessive use may induce arrhythmia, insomnia and in susceptible individuals, renal irritation. In the majority of individuals the morning cup of coffee and a small after dinner portion probably have no injurious action. Larger amounts, such as the three pints a day of the Army "travel" ration are inadvisable. Many persons have a marked idiosyncrasy against coffee, and by abstinence rid themselves of nervousness, insomnia, functional cardiac disturbances, etc. Such persons, if they require a hot drink, should use cocoa or one of the much advertised coffee substitutes. As a matter of fact there is no valid reason why any hot drink should be used.

Caffein and theobromin are closely related to the purins, but their causative relation to gout has not been established. It is wise, however, to forbid them to gouty individuals. Coffee some-

times causes digestive disturbances which are attributed to other constituents than caffein.

Tobacco. While tobacco is not an article of diet its use forms such an intimate part of the ritual of the dinner that it should receive mention. Smoked in moderation after meals, it often seems to ease digestion and stimulate peristalsis—in many persons acting as a mild laxative. Excessive smoking and chewing, in my opinion, is liable to induce or aggravate hyperchlorhydria and should be discouraged. Chewing has nothing to recommend it from a dietetic standpoint. It injures the teeth (at least by grinding them down) and wastes and probably vitiates the saliva. Perhaps the lack of the alkaline salivary secretion, as well as the irritating character of the swallowed tobacco juice, are factors in the causation of hyperacidity.

Arranging a Dietary—Sample Diet Lists. When called upon to arrange a diet for an individual it is extremely important to determine his previous dietetic habits, the number and character of the meals, individual dislikes and idiosyncrasies. Whenever possible the patient should furnish a list of foods taken, with the approximate amounts consumed, for a period of several days to a week. If the patient cannot remember these exactly for the previous week, each day's menu may be set down in detail at the end of the day, being careful not to allow the diet to be thereby unconsciously modified. In this way the faults of the diet may be easily analyzed and suitable modifications suggested. In prescribing a diet one should conform as far as possible, not only to the patient's taste, but also to the local customs and food supply. In the majority of cases general directions as to quality and amount of food will suffice; in others where a tendency to obesity, to diabetes or to gout exists, more precise limitations will be necessary.

Test diets, such as the Schmidt intestinal diet, and highly specialized diets will rarely be called for except in the presence of well defined disease. Occasionally the best way of determining a suitable diet is to start out with an adequate and well balanced, but extremely simple menu, such as that of Schmidt, and then by adding to it, or substituting, to adapt it to the patient's needs. In several cases I have obtained very happy results by this method. Occasionally radical changes in the diet or dietetic systems, such as an exclusive milk diet, chopped beef diet (Salisbury) or

vegetarian diet may be successful in starting the patient on the right course. Dietetic fads, however, are liable to lead into danger, as when persons limit themselves with undue strictness for obesity, etc. Vegetarianism is perhaps the most popular of all these fads, and while without danger when controlled by experts, is liable to induce subnutrition, from deficiency of suitable proteins, for example. A modified vegetarian diet which includes milk products and eggs is not subject to these dangers. At the present moment the tendency is to throw an exaggerated stress on vitamin containing foods. The other day a patient came to me suffering from incipient tuberculosis, for whom an obliging "lay" dietician had prescribed a diet of this character but eliminating *milk*, *meat* and *eggs!*

The diet should be as little restricted as possible and nothing should be forbidden without adequate reason. There is safety in variety. Other things being equal, instinct is a better guide than reason. Experience often goes in advance of science which follows haltingly with rational explanations. Many of the faulty ideas in regard to diet, still current today, reflect exploded theories of former decades or even centuries. The popular faith in meat extracts and in the efficiency of meat generally as a source of muscular energy, reflects in part the erroneous opinions of a great chemist (Liebig) of the middle of the nineteenth century. The superiority in healthfulness of white meats over dark meats is a similarly exploded theory which continues to survive. In the first division of middle life (40 to 55), moderation in general, combined with reasonable restriction of meats and sugars is the most important precept. Provided that cooking is good, and mastication is well carried out, very few foods will cause any difficulty. Nevertheless, flatulent foods and those of difficult digestibility such as baked beans, and corned beef and cabbage, should only be used occasionally. A commoner fault to be avoided is the too free use of spices and condiments, even of common salt.

If there is a tendency to constipation a diet may be selected from a list such as that which follows. A sample menu is added which may be varied to suit dietetic habits and all degrees of disturbed function. Articles marked (*a*) may be allowed unreservedly. Those in the other category (*b*) may be unnecessary or may require restriction in certain cases.

Constipation Diet.

Soups.	Vegetable soups made from (a) celery, asparagus, onions, green peas, (b) split peas, beans, tomatoes, etc.
Meats.	(a) Beef, lamb, poultry, fresh fish, sweetbreads, (b) pork, veal, liver, salt-meat, smoked meat and fish, oysters, clams.
Eggs.	Poached, boiled, scrambled, omelet.
Vegetables.	(a) Spinach, asparagus, celery, lettuce, carrots, peas, (b) rhubarb, onions, corn, tomatoes, parsnips, beets, squash, cabbage, turnips, string or shell beans, radishes, cresses.
Cereals.	(a) Oatmeal, wheaten grits, shredded wheat, (b) bran, agar-agar (cereal substitute).
Breads.	Rye bread, whole wheat bread, graham bread, Boston brown bread, corn meal bread, graham, whole wheat and oatmeal crackers, (b) pumpernickel, bran bread.
Fats.	Butter, cream, olive oil, bacon.
Sugars.	Sugar (brown preferred) with desserts, cereals, and beverages, jam, fruit, jelly, preserves, honey, syrups, molasses.
Beverages.	(a) Buttermilk, coffee, lemonade, hot or cold water (b) koumyss, kefer, cider, grape juice, carbonated beverages.
Desserts.	(a) Ripe fruits, stewed fruits (including berries), baked apples, dried prunes, figs and dates, (b) nuts, confectionery, ice cream, cake.
Condiments.	Salt, black and red pepper, (b) spices, horseradish, mustard, lemon juice.
Preparation.	Avoid the use of milk in cooking; condiments, spices and fats may be used moderately.
Avoid in General.	Rice, white bread, farina, sago, corn starch, puddings, custards, meat broths, milk, tea, cocoa, alcoholic beverages, pickles, cheese (cottage cheese permitted).
General.	Take a glass of old water and some fruit before breakfast and upon retiring; meat preferably once daily; take an abundance of fluids, fats, coarse breads or cereals, fruit and green vegetables; form regular habit of going to stool; eat regularly and chew food thoroughly.

Sample Menu.

On rising.	1½ glasses of hot water.
Breakfast.	Baked apple, oatmeal with cream and brown sugar, coffee, one egg, bran muffins and butter, honey.
10 A.M.	Two glasses of water.
Dinner.	Soup, meat or fish, two vegetables (one "green"), salad and oil, brown bread and butter, any dessert, fruit.
4 P.M.	Two glasses of water.
Supper.	Fruit with dry cereal, cream and sugar, omelet with jam, brown bread and butter.
Bedtime.	Dried figs, one glass of water.

If there is subacidity with loss of appetite and disturbed digestion, the following diet is applicable. This is particularly likely to be of use to those who are in the later division of middle life (fifty-five to seventy) when mastication is impaired by defective teeth and digestion is less vigorous than previously. Tender meat is often better digested than coarse fruits, vegetables and cereals. In later life Voltaire, according to Reveillé-Parise, obtained a dispensation from the Pope to eat meat on fast days: "Il avait disait-il l'âme Catholique mais l' estomac protestant." Following this diet list is a simple menu as suggested by Rose.

LIGHT OR EASILY DIGESTIBLE DIET.

Soups.	(a) Consummé, bouillon; chicken and mutton and clam broths, (b) gruels, barley, rice, etc., (c) strained milk soups or purées made with potatoes, rice, asparagus, green corn or peas, celery, oysters (stew), etc.
Meats.	(a) Squab, guinea, chicken, turkey. (b) broiled tenderloin or scraped and pan-broiled round of beef, tender roast beef (rare), lamb, sweetbreads, (c) boiled, broiled or baked fresh fish, raw oysters.
Cheese.	Neufchatel and cottage cheese.
Eggs.	(a) Raw, coddled, soft boiled, poached, (b) hard boiled (yolks), scrambled, omelet.
Vegetables.	(a) Baked or mashed white potatoes, rice macaroni (plain with milk), chopped spinach, asparagus tips, (b) lettuce, tender green peas, boiled carrots, (c) celery, young lima beans, cauliflower.
Cereals.	(a) Cream of wheat, hominy. (b) oatmeal, shredded wheat, cracked wheat, etc. (all thoroughly cooked), (c) prepared dry cereals, puffed wheat, etc.
Breads.	(a) Milk toast, toast (dry all through), zweiback, rusks, pulled bread, (b) stale white or whole wheat bread, crackers.
Fats.	Butter, cream, olive oil.
Beverages.	(a) Water (moderate at meals, freely between meals), milk, cocoa made with milk, (b) buttermilk, (c) freshly steeped tea or coffee (either once a day).
Desserts.	(a) Wine or lemon jelly, junket, Bavarian cream, custards, rice pudding, corn-starch, (b) plain ice cream and ices (take slowly). (c) baked apples, stewed fruit, (d) ripe fruit; apples, peaches, plums, grapes, berries if specially ordered.
Condiments.	(a) Salt and pepper (moderately), (b) lemon juice, French dressing, (c) mayonnaise and other condiments only by special order.
Preparation.	Cooking should be plain and free from strong condiments Meats should be broiled or roasted.

Avoid.   Fried foods, greasy foods, rich desserts, rich gravies, dressings, ice cold drinks, alcoholic beverages, hot breads and cakes, pickles, "high" cheeses, nuts, tough vegetables and meats, condiments, spices and sauces.

A Day's Food Plan for an Elderly Person (70).*

		Calories.
7.30 A.M.	Soft, sweet fruit or mild, diluted fruit juice (grape, pineapple, or apple)	75 to 100
	Well-cooked cereal with thin cream and a little sugar	100 to 200
	Toast or zweiback with butter	100 to 200
	Bacon or soft-cooked eggs	75 to 100
	Tea or coffee with cream and sugar	100 to 200
12.30 P.M.	Cream soup	100 to 150
	Fish or oysters, cheese soufflé or fondue	100 to 200
	Rice, or baked or riced potato	75 to 100
	Toast or zweiback with butter	100 to 200
	Stewed fruit or fruit jelly with gelatin or tapioca	100 to 200
4.00 P.M.	Tea or coffee, or bouillon, or malted milk, toast or crackers	75 to 100
6.00 P.M.	Chicken, or lamb chop, or broiled beef balls	100 to 150
	Riced, or baked, or mashed potato	75 to 100
	One other cooked vegetable (soft enough to mash with a fork)	25 to 100
	Toast or zweiback, or Huntley and Palmer dinner biscuit	75 to 100
	Custard, or cereal pudding, or gelatin dessert	100 to 200
	Tea or coffee with cream and sugar	100 to 200

The diet list which follows is particularly intended for hyperacidity, but is adaptable to a number of other conditions when appropriate modifications are made. It will then serve for diarrhea or the gouty diathesis, for incipient arteriosclerosis, nephritis, etc.

Hyperacidity Diet:

Soups.   Strained milk soups made from (a) potatoes, barley or rice, (b) asparagus, celery, green peas, etc.

Meats and Fish.   (a) Chicken, guinea, fresh fish (boiled), (b) beef (well done or boiled), roast lamb, lamb chops.

Cheese.   (a) Cottage, Neufchatel, (b) Philadelphia cream.

Eggs.   (a) Soft boiled, poached, (b) scrambled, omelet.

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* Feeding the Family, W. S. Rose, New York, 1917, p. 190.

Vegetables.	(a) White potatoes mashed or baked, rice, hominy, macaroni, plain (b) spinach, asparagus, cauliflower, lettuce, (c) young lima beans, young string beans, green peas, etc.
Cereals.	(a) Cream of wheat, (b) shredded or cracked wheat, oatmeal.
Breads.	(a) Toast, zwieback, pulled bread, arrowroot biscuits, (b) stale white bread, soda crackers, (c) whole wheat bread, graham bread.
Fats.	(a) Butter, olive oil, cream, (b) crisp fat bacon.
Beverages.	Milk, cocoa, water (not too cold, may be taken moderately at and freely between meals
Desserts.	(a) Custard, junket, gelatin, (b) cornstarch, sago, tapioca, rice pudding, (c) ice-cream, (d) baked apples, strained apple sauce, stewed peaches, prunes
Preparation.	Cooking should be plain. Vegetables, (peas, spinach, potatoes), when possible should be passed through a colander.
Avoid in General.	Vinegar, lemon, sugar, pepper, relishes, catsup, spices, meat soups and gravies, broths, bouillon, rare meats, liver, kidneys, game, cabbage, baked beans, peanuts, radishes, cucumbers, parsnips, turnips, puddings, pastry, strong tea and coffee, highly salted and smoked foods, ice-cold drinks, carbonated and alcoholic beverages.

SPECIAL DIRECTIONS FOR ARTERIOSCLEROSIS.

Permitted.	Milk soups and vegetable purées. Cottage and Neufchatel cheese, milk, eggs, butter, beef and lamb in moderation or occasionally, fowl, fish (except salmon, herring, sardines and salted and cured fish generally), oysters. Succulent vegetables (lettuce, string beans, asparagus, spinach), potatoes, baked or mashed, very moderately, rice, cereals (except bran), stale bread, dry toast, zwieback.
Forbidden.	Broths, bouillon, clear soups made from stock. Liver, kidneys, beans, cabbage, corn, turnips, parsnips, sweetbreads, peanuts, rich or high cheeses.
Advised.	Water moderately between meals. Mild exercise, outdoor, etc. Massage, warm baths.

In cases in which overweight is not amenable to general restrictions, it may be necessary to control the intake more strictly and to prescribe a diet in which the protein, fat and carbohydrate, as well as the calories, are carefully calculated. This is a somewhat tedious procedure, but is facilitated by the many convenient tables which are now available (*e.g.,* Food Values by Edwin A. Locke, or the table compiled by Irving Fisher, orginally published in the Journal of the American Medical Association and re-issued

by the Life Extension Institute of New York). The diet which is appended is one of several from my article on obesity in Da Costa's Handbook of Medical Treatment (*l.c.*).

	Gms.	P.	F.	C.-H.	Cal.	
Breakfast.						
Apples (1)	150	0.5	0.5	16.2	72	
Eggs (2)	100	13.2	12.0		160	
Butter balls	15	0.2	12.8		116	
Roll, French (1)	39	3.3	1.0	21.7	109	
Sugar, cube	7			7.0	28	*Café*
Milk	100	3.5	4.0	4.5	68	*au lait*
Coffee	100					
		20.7	30.3	49.4	553	
Lunch or Supper.						
Tea and lemon ...	200					
Sugar, cube	7			7.0	28	
Cold chicken	100	32.1	4.4	2.1	176	
Asparagus	100	2.1	3.3	2.2	47	
French dressing .	11		8.0		72	
Toast, ½ slice	10	1.2	0.2	6.1	31	
		35.4	15.9	17.4	354	
Dinner.						
Oysters (6)	85	5.3	0.1	3.2	43	
Celery	50	0.5		1.6	8	
Mutton boiled lean	100	30.9	4.5		164	
Squash	100	1.4	0.8	13.6	67	
Spinach	100	2.1	4.1	2.6	56	
½ egg	25	3.3	3.0		40	
Swiss cheese	20	5.5	7.0	0.2	86	
Cantaloupe	232	0.7		10.5	45	
		49.7	20.4	31.8	509	
Summary		105.8	66.6	98.6	1416	

This diet is intended for a man of average size with a moderate degree of obesity. By the addition of a roll and butter, a potato and a simple dessert, the caloric value will be increased to 2000 calories. This would represent a slight restriction such as one would be likely to prescribe in a borderland case, that is, one just overstepping the normal.

In cases of subnutrition, it is well to calculate a well balanced and digestible diet sufficient for all the theoretical needs of the

patient, and then to add to this suitable quantities of milk, plain or fortified with cream, or malt sugar and cream, thus increasing the caloric value, as required, by five hundred or more calories. Very often it will be necessary to combine the dietetic treatment with a modified rest treatment.

The examples which have been given might be multiplied, but will, I think, suffice to illustrate the method of procedure. Attempts to improve the health of the middle aged by means of diet presuppose careful and continuous observation or periodic health examinations. Otherwise one cannot hope to detect tendencies to disease at a time when they can be readily controlled by diet.

Summary and Conclusions. We have now reviewed the relation of food to the maintenance of health and nutrition in middle life and have considered the modifications in the diet which are necessitated by various factors, the majority of which are physiological, though some border on the pathological. Prophylaxis must take into consideration minor or incipient disturbances of function or even of structure, though it does not deal with fully developed diseases. Life insurance and life extension examinations, as well as health examination in industrial establishments, offer exceptionally favorable opportunities for the detection of diseases of middle life in their incipiency, and hence furnish indications for dietetic, and other prophylactic measures, at a time when they still have a good chance of success.

To the general practitioner more than to the specialist are offered opportunities for this type of work. In view of his confidential relations with the family he may frequently suggest useful alterations in diet which may be of value to members of the family not under his immediate care. If he can induce his clientele to submit to periodic examinations such as are now generally urged by dentists, he can accomplish much more than he does at present with so-called curative treatment. This statement presupposes a thorough grasp of dietetic principles.

We have found that the physiological requirements in middle life differ little from those of the preceding period. The principal point to be borne in mind is that there is a reduction in energy requirements of from five to ten per cent. (in "round numbers"), depending on the age. This is correllated with a cessation in growth, and a tendency to restrict active movements and exercise. There is also a lessened demand for protein. Those

who disregard these facts and continue to eat as heartily as in adolescence are almost sure to suffer. The danger is greater if the appetite is unduly stimulated by cocktails, *hors d'oeuvre,* meat soups, highly seasoned dishes, spices and condiments. Most of these substances used in excess are injurious to the stomach, as well as to the liver and kidneys, which must detoxicate or excrete them. As previously stated, after forty, moderation is the chief prophylactic rule.

Very closely related to the dangers of overindulgence in general are the perils incurred by those with a special predilection to obesity, diabetes and gout. The first named disorder is in fact due to general hypernutrition, particularly to excess in carbohydrates and fats. The second is due to a relative excess of carbohydrates in persons with impaired pancreatic function. The development of the active diseases may often be prevented or deferred by timely abstinence and may be hastened by dietetic abuse. The minor manifestations of gout, with which we are alone concerned, similarly seem to be associated with difficult excretion of uric acid and purins and are relieved or prevented by a diet in which meat and proteins generally are restricted and purin rich foods (glandular organs, *e.g.*), and alcohol are forbidden.

Similar restrictions are of value in incipient nephritis, vascular hypertension, arteriosclerosis and hepatic disorders. In the presence of jaundice or hepatic insufficiency, fats are badly tolerated. In myocarditis or weakened heart from any cause, overloading of the stomach is dangerous. Foods causing flatulence, such as beans and cabbage should be forbidden.

The minor digestive disorders—hyperacidity, subacidity, functional diarrhea and constipation—are frequently due to a badly balanced or otherwise unsuitable diet. Their treatment has been considered in a previous section. Subnutrition has also been sufficiently discussed.

When we come to evaluate diet as a means of prolonging life we can only deal in surmises. We have all seen cases in which the institution of a suitable diet has seemed to check the progress of a definite nephritis, and less often of a beginning cirrhosis of the liver. The symptoms of gout and gastro-intestinal disorders can certainly be relieved by means of diet, and we have strong reasons for believing that the onset of arteriosclerosis and other senile changes is thus deferred. Many authors attribute many of the

functional disorders of middle life, as well as the development of senile changes to gastro-intestinal fermentation and putrefaction or so-called auto-intoxication. This hypothesis is an attractive one and is held by a host of physicians. From a scientific standpoint its existence as a disease entity has not been established. Methods of treatment based on this hypothesis are in general useful, if not pushed to extremes. From a dietetic standpoint they consist principally in the prescription of a non-fermentative vegetable diet, combined with milk and milk products, *e.g.,* koumyss, kefer, Bulgarian buttermilk and cottage cheese. Whatever we may think of the theory we cannot deny the value of this type of diet in some persons with ill defined "lithemic" or "toxic" symptoms. We cannot be so sanguine as to believe that it will prevent the manifestations of old age as some enthusiasts have claimed.

LITERATURE.

During the last decade the files of the Archives of Internal Medicine, the American Journal of Physiology and the Journal of Biological Chemistry, have been rich in articles dealing with diet and nutrition. In recent years advances in these lines have been summarized at frequent intervals in the editorial pages of the Journal of the American Medical Association.

The following are valuable for general reference: Science of Nutrition, Graham Lusk, 3d ed., Phila., 1917. Nutrition and Clinical Dietetics, Carter, Howe and Mason, 2d ed., Phila., 1921.

For the newer ideas in regard to nutrition, consult: The Newer Knowledge of Nutrition, E. V. McCollum, N.Y., 1922; also his article in Vol. I, Oxford Medicine. Studies in Deficiency Diseases, Robt. McCarrison, Oxford Med. Pub., 1921.

For diet lists and necessary data for their preparation: Diet Lists of the Presbyterian Hospital, H. S. Carter, 2d ed., Phila., 1919; also Locke, E. A., "Food Values," and Rose, M. S. "Feeding the Family," 1917.

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Muscular Exercise in Middle Life

BY

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THE NEED FOR EXERCISE.

This chapter summarizes the essential fundamental material given in the author's text on the Physiology of Exercise in its chapters dealing with persons over forty. People over forty need less exercise than those under forty; they need the smaller amount more, however, than those under forty need the larger amount. The younger person still has a fair bank account from his inheritance. The older person has less physical reserve. The present method of living reduces the amount and variety of muscle movements, particularly the big muscle movements related to health. These conditions obtain all through life, beginning in early childhood.

MODERN CHANGES IN CHILDREN'S ENVIRONMENT.

Formerly children worked with their parents. They learned by doing work with their hands, gradually increasing the big muscle work relating to health. They imitated their parents even in their plays. The boys began early to assist in hunting and fishing. They learned horsemanship, the use of the spear, and the bow and arrow. The girls helped in house and garden with rude hand tools. The grinding of grain in the pestle is a good example. The boys and girls spent much time in the open contending with nature in their sports. There were no schools.

Now the child begins school at from four to six years of age. The chief emphasis in the schools is put upon reading, writing, arithmetic and learning how to keep quiet. The big muscle movements related to health are relegated in many of the so called best schools to a relief drill of three minutes approximately four times per day plus twenty minutes per day of physical education. These twenty minutes per day are often used largely to correct

(45)

the bad habits due to the school desk. This time is not as a rule used to build up organic vigor. The muscles used in school are chiefly those of the eyes, tongue, lips and fingers. The use of these small neuro-muscular mechanisms is not related to health. The small muscle movements should be integrated with the large muscle movements so definitely related to the child's emotional and play interests. Even in comparatively recent years children went to school three months in the winter to learn to read, write and cipher. The rest of the time they helped the parents at home.

Home Conditions. The home conditions have largely eliminated the chance for big muscle activity either in work or play. Woods, pastures and the care of animals has been taken from more than half of the child population. Gardens, backyards, barns and attics are gone from the modern home. Many of the swimming holes are contaminated with industrial waste or sewage. Recently a New York paper described the spraying of the children during a hot day by the fire department. This was a brilliant idea but a poor substitute for the old swimming hole. The streets are no longer safe play spaces; the trollies and autos have increased the speed of traffic and the danger to children. Not only has the traffic speed increased but the street has relatively narrowed; there are more houses on many streets; the frontage per house has decreased, and the houses in many cases have been built one above the other in apartment blocks. Most of these streets were built for single family houses and slow moving traffic.

Recreation. Today, the recreations of children are too largely attending movies and reading novels. These activities continue from the schoolroom, using chiefly the small eye muscles. This removal of big muscle activity from both work and recreation requires fundamental adjustment if our children are to have organic vigor when over forty years of age. Wm. T. Harris,[1] Ph.D., formerly United States Commissioner of Education, wrote as early as 1891, "Our civilization is so bent on the conquest of nature and the production of wealth that it perpetually strains its supply of nervous energy and produces disaster." Here is the specific problem of our time for hygiene to meet—How to restore and conserve nervous energy. There are three factors here: First the one of food and its proper assimilation; second, the factor of sleep and rest; third, the factor of exercise, muscular and mental.

The loss of big muscle activity which was formerly related to occupation and incidentally to leisure must be secured for children now through definite community planning during the school day and during the child's leisure time activities. The need cannot be met by twenty minutes per day of corrective gymnastics. Both the child's school and leisure time should give approximately one-fourth of the time to organic and neuro-muscular activities. These should be related to health, to skill of the hands, and to games which will aid in securing neural stability and organic health. In addition to poor physical environment for activity, medical skill is saving a larger proportion of children of less physique than formerly. This group adds to the number needing attention after forty. Mortality due to zymotic diseases has decreased materially in recent years. Diseases of the nervous system have increased during this same period.

Three things are essential to child health and to later adult health:

First: Correction of obvious physical defects, *e.g.,* of carious teeth, tonsils, adenoids, nasal defects, eyes, etc.

Second: Establishment of correct health habits.

Third: Abundant big muscle activity regulated to the needs of the child.

MODERN CHANGES IN ADOLESCENT ENVIRONMENT.

The adolescent age is the nascent period for the development of strength, speed, skill and coördination of the small with the big muscles. Many of the conditions mentioned under children persist through the adolescent age. Students in classical and commercial high schools still use chiefly eye, tongue and finger muscles. In the technical high schools the same muscle groups are used with the added advantage of less confining positions. The work, however, aside from the fine adjustment of tools is largely done by machinery, not by pupils' muscles. Here again the small muscles function largely to the exclusion of the large organic muscles of the trunk and legs. Even in the sports, school boards, physicians and public sentiment must carefully protect the best pupils from furnishing a spectacle of specialized sport for the community to the exclusion of the physical needs of the average pupil. These great adolescent sports may have much social value

in increasing community spirit. The individual players on the best teams must be protected from over exercise and the average pupil both boy and girl given a chance for normal development. The city property committee and the board of health must coöperate with the school board in securing for all pupils an opportunity for normal growth and development. The cities and towns have practically preëmpted the child's time for health education. They have the administrative machinery but have not yet adjusted it to meet these urgent health needs.

Dr. W. T. Porter,[2] of Harvard Medical School, studied the growth of Boston school children monthly for ten consecutive years. For the first time in this country we had the "individualizing method" in place of the "generalizing method" used on a larger scale. The old "generalizing method" measured all the children once and divided them into groups according to age, sex, height and weight. This method showed the average growth for each age, but nothing on the growth of the individual pupil. Half the pupils might, for example, gain ten pounds during the year and the other half lose ten pounds without changing the statistical average. The "individualizing method" will show these changes and also the seasonal growth, provided the data is distributed according to calendar months rather than age in months. Boston children grow more rapidly from June to October, with the exception of December to January. The average monthly gains in weight for boys from six to thirteen years of age are given in the following table:

Jan. to Feb.	Feb. to March	March to April	April to May	May to June	June to July	Sept. to Oct.	Oct. to Nov.	Nov. to Dec.	Dec. to Jan.
0.18	0.47	0.22	0.16	0.05	2.23	0.96	0.61	0.63	0.98

It will be noted that the large gains are from June to October with the exception of December to January. Are these gains during the summer and Christmas vacations due to absence from the less healthy environments and activity of the schools? Some available data points toward such a conclusion. Dr. D. A. Sargent[3] of Harvard presented statistical studies in 1912, showing that public high school boys averaged 68.1 inches and private and secondary school boys, 69.5 inches in height. In weight, the public school boys averaged 136.7 pounds and the private school boys

145.5 pounds. Public school boys averaged 1.4 inches less in height and 8.8 pounds less in weight.

Dr. Paul Goodin[4] studied the effect of exercise on 114 boys from 14½ years to 18 years of age for three and a half years. Fifty of these boys elected regular daily exercise. Another group of fifty boys took simply the required exercises once per week with the occasional prescribed marches. The boys taking regular exercise showed in comparison with the other group a slightly larger increase in height, a larger increase in weight and a still larger increase in chest girth.

Growth During Adolescence. A maturing child needs careful watching. The rate of growth varies greatly at this period. McCurdy's[5] studies show that boys who remain in the prepubescent stage average during one year and five months an increase in height of 2.8 inches, while the pubescents increase 4.46 inches. The prepubescents show an average gain in weight during this same period of 8.55 pounds and the pubescents 23 pounds. During this same period, boys who remained prepubescent increased in lung capacity eleven inches, those changing to pubescents increased thirty-two inches and the pubescents changing to post pubescents increased their lung capacity forty inches. The amount of increase in lung capacity during this period is practically double if the pubertal change occur during summer. Deaver's[6] table given below shows these increases in both lung capacity and muscular strength:

TABLE SHOWING DIFFERENCES BETWEEN CHRONOLOGICAL AND PHYSIOLOGICAL AGE IN REGARD TO STRENGTH.

Chronological Age	Physiological Age	Right Forearm	Left Forearm	Shoulder Retractors	Lung Capacity
13 yrs. 4 mo.	P. 1	46	36	24	130
14 " 10 "	P. 3	80	68	58	190
14 " 5 "	P. 1	45	37	24	110
15 " 10 "	P. 1	50	45	30	125

It will be observed that the older boy shows far less gain than the younger boy who has matured more rapidly. An eastern city during 1922 weighed 10,571 school children, finding thirteen per cent. of them ten per cent. or more under weight. Growth

rates of children, particularly the increase in weight, serves as a
good index of physical health.   Failure to mature properly dur-
ing adolescence helps lay the foundation for ill health after forty.
Normal muscle activity is an essential element in securing rugged
health.   Such exercise is intimately associated with the founda-
tion of correct health habits in sleep, diet, etc.

MODERN CHANGES IN ADULT ENVIRONMENT.

Steam cars, electrics and autos have in modern times reduced
walking to a minimum.   The telephone, telegraph and wireless
have made it possible to do much business without leaving the
office chair.   The modern newspaper brings to the breakfast table
each morning the news and troubles of the world.   The whole en-
vironment of the modern world is geared up to increase nervous
expenditure and decrease big muscular output.   Insanity and
nervous diseases are increasing because of this loss of balance be-
tween neural and muscular work.   The modern business man
needs in his business simply strength enough to sign his name,
raise the telephone receiver to his ear, walk to his auto and to
sit in a chair sufficiently erect to have his head above the table.
With such conditions, irritability easily takes the place of alertness.
A goodly minority of men over forty wake up to find they have
lost too large a measure of their physical and nervous stamina
and stability.   Machinery has taken the place of muscle not only
with the business man but with the farmer and with the indus-
trial worker.   The hand tools of the farm have given way to the
mowing machine, the horse rake, the hay tedder and the horse
pitchfork.   The tractor does the heavy work and the Ford looks
after the transportation.

In the shop, automatic machinery has largely taken the place
of hand labor.   Inside the home, modern machinery has come
more recently, but is just as surely reducing big muscle work.
The youth who has failed to integrate neuro-muscularly the small
muscles of the eye and hand with the big muscles of trunk and
legs has failed to gain his due measure of nervous stability.   The
adult over forty who does not continue this integrative function
through gymnastics, games or aquatics is slipping back faster
than he should.

The average physician knows the facts given in the preceding
brief summary of environmental changes which have occurred

largely during the relatively brief span of the last one hundred years. Physicians, especially those in school and public health work, are becoming health salesmen. The "shot gun" prescription has gone. Definite diagnosis and prescription are taking their place. The prescription of definite types of exercise for people over forty is becoming more common. These types of exercise will be discussed in the next section.

FUNDAMENTAL PHYSIOLOGICAL TYPES OF EXERCISE.

No classification can be absolute. The condition of the patient in a measure determines the classification. Bodily strength is a variable factor related to illness and previous training. An exercise of moderate speed for one might be an exercise of endurance for another person.

The physiological types of exercise may be divided into three groups, first, Active Types; second, Postural Types; and third, Passive Types.

Active Types. The active types of exercise include exercises of speed, strength, endurance, alertness, attention and skill.

1. *Speed*. In exercises of speed, movements follow each other with great rapidity. They necessarily fall below the maximum of effort for individual endeavor for that group of muscles. In running, the limits of muscular, cardiac and respiratory exertions are rapidly reached through the accumulation of the dose.

2. *Strength*. These exercises demand large endeavor with each contraction. The slower rate of individual contraction, combined with a slower rhythm in the repetition of the contractions, permits large dosage of work in a brief time. Strength exercises which approach the extremes of "effort" mechanically interfere with respiration. In technical "effort" the glottis is closed and the chest walls are fixed. The dangers of such extreme contractions will be discussed in Chapter IV, particularly in relation to systolic blood-pressure.

3. *Endurance*. The essentials in endurance exercises are the repetition of moderate endeavors for a considerable period of time, Exercises which lend themselves easily to this type are long distance swimming, tramping, mountain climbing, etc.

4. *Alertness.* These exercises include rapid responses to un-foreseen situations, *e.g.,* boxing, wrestling and fencing. The particular activity of the individual depends upon the movement of an opponent. In team games like base ball there are periods of relative inactivity while the ball is being returned to the pitcher followed by active alertness when the ball is batted.

5. *Attention and Skill.* These exercises emphasize the neural side of muscular exercise. Many of these types are given to command by a teacher. Illustrations would be, marching and calisthenics to command, and in reëducation exercises in locomotor ataxia the attention is concentrated on both the effort and the precision of the movement. Skill gained during youth may give the foundation for later physical recreations definitely related to health.

The person who can never attain moderate skill in golf because of faulty early training has lost one of the elements essential to healthful participation in that game. The person who cannot catch, throw or bat a ball is seriously handicapped in his physical recreation. The encouragement to activity is greatly decreased if the individual lacks skill. More elementary forms of exercise must be devised for such persons as they seldom become expert enough after forty if they have not had the preliminary physical education to enjoy exercises of skill.

Postural Types. Good posture is definitely related to good health. Balanced muscle tone and well developed neuromuscular sense are positive factors in securing correct posture. Correct postural muscle habits involve three types of contraction.

1. Concentric or isotonic contractions are where the muscle actually shortens during activity.

2. In eccentric contractions the muscle increases its length during work.

3. In static or isometric contractions the muscle remains the same length. These three types might be illustrated in the same muscle. In raising a weight with the hand the biceps does a concentric contraction, in holding the weight at the same height the biceps is doing static work, and in lowering the weight the biceps is doing eccentric work.

Good posture means the training of the posterior cervical group of muscles to maintain a relatively shorter position than they ordinarily keep and the sterno-cleido-mastoid group a slightly longer

position. The mastoid group is kept short in holding up directly the clavicle, the manubrium and indirectly the whole thorax in its normal position. It means that the lax abdominal muscles are shortened in concentric and static contractions enough to eliminate the pendulous abdomen.

An important element in pronated and flat feet is the loss of muscle tone in the muscles supporting the arch of the foot. Ordinary contractions bring in but few of the fibers in a muscle. The old idea that a moderate contraction brought in all of the muscle fibers in a group moderately, and a vigorous contraction the same fibers more vigorously has been thoroughly exploded. A weak contraction brings in few fibers, a strong contraction brings in many fibers. Keith Luccas,[7] the English physiologist, has shown that the "all or none theory" applies also to the skeletal muscles. This fact has been corroborated by others in this and other countries. Vigorous contractions bring in many unused fibers. The neuromuscular education of these relatively unused fibers is an important factor in securing good postural results.

Passive Type. This type is used chiefly where the patient is too weak to raise the weight of the limb. In these cases the movement is made in whole or in part by an operator depending on the nervous integration and muscular strength of the patient. Passive movements are also used with the various types of contractures. These types are usually in the hands of specialists as they are ordinarily preceded by electrotherapeutic and hydrotherapeutic treatment. This type has received thorough treatment from the hands of the medical specialist. Space does not allow the development of this topic nor is there as large a need of such treatment because of good texts on this topic.

EFFECTS OF DIFFERENT TYPE OF EXERCISE ON BODILY FUNCTIONS.

CIRCULATION.

The average adult normal heart rate is given by various observers, in the lying position as 66 to 69 beats, in the sitting position at 70 to 72 beats, and in the standing position 78 to 81 beats per minute.

The normal heart rate of individuals varies beyond these averages. A study of normal adolescent heart rate lying, showed,

in general, variations between 60 and 79 beats per minute, and standing between 80 and 99 beats per minute. There were, of course, extremes beyond these rates. The adult shows diurnal variations in pulse rate. The lying averages were morning, 63; afternoon, 73; evening, 65. The standing averages were morning, 80; afternoon, 86; evening, 76. These figures are based on 1,327 observations on 15 healthy adults. The morning tests were between 6:15 and 7 A.M.; the afternoon tests were between 1:30 and 4 P.M., and the evening between 9 and 11 P.M.

Speed Exercises. Speed exercises increase the heart rate more than any other type of exercise. Bowen[8] showed an increase from 68.6 to 91.3 beats per minute in 50 seconds, even with tapping a telegraph key rapidly. The bulk of the increase came during the first thirty seconds or up to 89.4 beats per minute. He also showed that the speed in bicycling is a larger factor in increasing the pulse rate than the amount of work done. The standing rate in a young adult increases, according to Wyman[9] in the 220 and 440 yard runs as follows:

HEART RATE PER MINUTE.

Normal Rate Standing.	Rate after Running.	Difference.
90	220 yd. run 129	39
84	440 yd. run 156	72

These figures emphasize the necessity of gradation of exercises. The effect of training is shown by Hartwell and Tweedy[10] in the comparison of the athletic and the non-athletic group. Before running up and down stairs the pulse of the athletic group was 76 and of the non-athletic group 78; after the exercise, the pulse rate for the trained group was 100, and for the untrained group 110. These untrained hearts all return to normal more slowly. The rapid increase in heart rate in speed exercises has as one of its chief factors the cerebral inhibition of the cardio-inhibitory center.

Endurance Exercises. The best adult study of the effect of endurance exercises on heart rate is by Barach.[11] These studies are on young adults rather than on individuals over forty. They give, however, the basal physiological effects of endurance exercises. The average lying and standing pulse before the race was 74.8 and 78.3, within 5 minutes of the close of the race the average was lying 95.6, standing 111.3.

The increase in pulse rate in endurance exercise continues for some time after the exercise ceases, due to the stimulus of previous metabolic activity. Adrenin may also be a factor in this stimulation.

Strength Exercises. Strength exercises do not materially increase heart rate unless they add speed or endurance features. Lifts of 350 to 450 pounds are made with little or no increase in heart rate. Light strength exercises often reduce the pulse rate both during and after work.

Training. A course of regulated graded exercise reduces the rate of the resting pulse. The trained heart also returns to normal more rapidly after exercise. Many other factors affect the pulse rate. Altitude increases the rate. Robinson, the resident manager of the Summit House at Pike's Peak, had an average pulse of 82; it decreased to 60 after the descent, rising again slowly to 70.

Air movements about the body increase the pulse rate. Lyth's[12] study illustrates this fact. With an air temperature of 44° F., standing in the wind gave a pulse of 87.2; in the shelter, of 77.6. Riding inside a tram car the pulse was 75.5; outside, the pulse rose to 100. Automobile riding, particularly in an open car, definitely stimulates cardiac action. The colder the air the greater the stimulation.

Loss of sleep increases the heart rate as a rule. Increase in the respiratory rate increases the heart rate. Increased metabolism and rise in body temperature increase the heart rate.

BLOOD-PRESSURE.

An examination of the work of some twenty careful observers on blood-pressure, together with the author's own cases, gives the following summary of normal ranges:

Systolic mm. Hg.	Diastolic mm. Hg.	Pulse mm. Hg.	Capillary mm. Hg.	Venous cm. of H_2O
110 to 135	65 to 97	26 to 45	18 to 45	2 to 20

The normal systolic and pulse pressures apparently rise slightly during the day. Observers do not agree on the diurnal variations of the diastolic capillary pressures. Venous pressure gradually rises during the day.

Speed Exercises. The first effect of speed exercises is to raise the systolic, diastolic and pulse pressures. Lowsley's[13] study of

100-yard runners showed increases immediately after the race as follows: systolic, 45 mm. Hg; diastolic, 17 mm.; and pulse pressure 28 mm. The general tendency is for the systolic and diastolic pressures to go below normal 10 to 15 mm. within the first hour. The pulse pressure fluctuated above and below normal. Wyman's[14] study of young adults shows average systolic pressures before the 100-yard run of 117 mm. Hg and immediately after of 150 mm., in the lying position. In the standing position the normal systolic pressure was 117 mm. and after the run 133; with the capillaries in large muscular areas dilated, it is rather common to have a systolic pressure fall in the standing position. The author had a striking illustration of this fall in pressure. Following a rapid run, examination showed a lying systolic pressure of 168 to 170 mm. Hg, while the standing pressure was but 100 to 104 mm. This pressure in the standing position approximately within two minutes gradually decreased to 60 mm. When the man's pressure decreased from 70 to 60 he was, in each case, obliged to lie down. In the sitting posture, the decrease in pressure was slower and could be prevented by pressing a board against the abdomen, thus increasing intra-abdominal pressure. The difference between horizontal and standing pressures is a good index of cardiovascular tone.

Endurance Exercises. Barach's[15] study gives a good illustration of the effect of this type of exercise. In the horizontal and standing positions, the average pressures were as follows:

	Systolic	Diastolic	Pulse pressure
Horizontal			
Before race	127.8 mm.Hg.	96.7 mm.Hg.	30.3 mm.Hg.
After race......	103.6	82.5	22.0
Standing			
Before race.....	124.9	95.9	29.3
After race......	100.2	82.4	19.1

A fall in pressure of approximately twenty per cent. is clearly seen in both the horizontal and standing position following the race. Heart murmur cases, probably from fatigue of the papillary muscles, gave lower pressures. These systolic pressures returned slowly, taking four to five hours. The author has found similar

smaller reductions of systolic pressure, following exercises of moderate endurance, particularly during warm weather.

Venous Pressure. Hooker's[16] study shows an average increase in pressure in different individuals of 6 to 18 cm. of water following exercise. These individual pressure increases varied from 9.5 to 32 cm.

Venous pressure rises with age and with fatigue. Such pressure measurements might well be used as an index of skeletal muscle tone. The older persons through inactivity have largely ceased to aid the return flow of the blood through muscular activity.

Strength Exercises. Strength exercises increase the systolic pressure immediately *during* the exercise to a considerable height. Seventy-seven experiments on twenty-three men by the author gave an average normal standing systolic pressure of 111, a pressure during lifting of five seconds duration on our ordinary dynamometer of 180 mm. Hg. The pressure returned to normal in from two to three minutes, many of them within fifteen seconds. The average weight lifted varied from 260 to 548 pounds. The systolic pressure averages varied in different individuals during the lift from 146 mm. Hg to 210 mm. Hg. The larger lifts were, in general, associated with higher pressures. Expiratory efforts with the glottis closed in three men gave higher systolic pressures than their pressures during lifting. The large increase in systolic pressure is due to the increase in intra-pulmonic and intra-abdominal pressure rather than to contraction of the skeletal muscles as stated by Traube.[17]

Intra-pulmonic pressure during expiratory efforts with the glottis closed showed an average increase in systolic pressure of 60 mm. Hg. The intra-abdominal pressure during expiratory efforts with the glottis closed gave an average increase in systolic pressure of 87 mm. Hg. One individual during lifting averaged an increase of 77.6 mm. Hg of intra-abdominal pressure. The same individual averaged an increased systolic pressure of 53.8 mm. Hg during lifting. It will be noted that the increase in intra-abdominal pressure during lifting is greater than the increase in systolic pressure during lifting. The intra-pulmonic pressure was determined by finding how high the subject could hold a column of mercury, by the vigorous expiratory effort of blowing into a tube for five seconds.

The intra-abdominal pressure was secured by connecting an ordinary mercurial manometer with a stomach tube inserted in the stomach, partly filled with water. The expiratory efforts or lifting exercises were made with these connections for a period of five seconds. These experiments suggest the care which should be taken to avoid extreme straining at stool by persons with weakened arteries. Expiratory efforts such as those made during straining at stool may raise the systolic pressure above that of extreme exercises of strength. The systolic pressure increases were greater in all three men studied during expiratory efforts with the leg and arm muscles entirely flaccid, than with the most vigorous exercises of lifting 260 to 548 pounds. But three men were given regular tests in intra-abdominal pressure during lifting because of the difficulty of training men to exercise with the stomach tube and half a liter of water in the otherwise empty stomach. The interest of Harvard medical students in the subject made possible this research.

Heart Volume Output. The amount of blood sent out at each beat depends upon the size of the heart and the completeness of its filling. The per minute volume depends upon the factors just mentioned and in addition upon the rapidity of the beat. The average output per beat is given by Starling in his physiology as 60 c.c. During vigorous exercise the athlete puts out 180 c.c. per beat, or an increase of three fold. He also increases the number of beats between two and three fold. The per minute output of the heart may increase from 5 to 20 liters during exercise. The untrained man increases his output chiefly by increasing the rate, the trained individual increases more the output per beat and keeps down the rate; moderate exercise of a general character will increase the output per beat and save increasing the rate.

RESPIRATION.

Fundamental Data. In considering the effects of exercise on respiration we exclude for the present constrictions of the chest from holding the breath and those from clothes constrictions, *e.g.*, corsets and tight clothing. Mechanical interferences due to nasal obstructions are also excluded. Reduced respiratory efficiency from tuberculosis is not considered. Many old people have an unnecessary thoracic rigidity due to inactivity. Respiration rate

varies in general from 40 per minute at birth to 25 at five, 20 at fifteen; 18.7 at twenty-five; and about 17 at fifty years of age.

The Carnegie Institution of Washington studied a group of International Y.M.C.A. college students. They found an average respiratory rate for these young adults of 15.6. Kolb's[19] average rate for oarsmen was 12 respirations per minute. Demeny's[20] study of ten soldiers during five months of training showed a decrease in respiratory rate from 20 to 12. These men were taking regular physical education practice. Clinical evidence indicates a reduction through training of both cardiac and respiratory rate. The respiratory rate is slightly faster in women than in men, in spring than in winter, and in high altitudes than at sea level.

The lung capacity as shown by an ordinary spirometer varies according to height, the shorter person having less lung capacity than the taller ones. Amherst College studies show lung capacity in cubic inches as follows:

Height in inches.	63	65	66.9	68.9	70.9	72
Lung capacity in cubic inches.	193	210	221	240	270	273

The increase in lung capacity per inch of height is greater in tall than in short men. The average increase in lung capacity for men 63 to 67 inches tall was 7 cubic inches per inch of height, for men 67.3 to 70.9, 13 cubic inches.

Men over 5 feet 7.3 inches had approximately twice as great an increase in lung capacity per inch increase in height as the shorter men. Men five feet three inches tall had 3 cubic inches of vital capacity per inch of height, men five feet ten and nine-tenths inches had 3.8 inches of vital capacity per inch of height. Dreyer's[21] recent work, "The Assessment of Physical Fitness," gives detailed tables dividing all people, men, women and children, into three groups according to physical fitness. He states that he has found that an individual living a healthy outdoor life or compensating for a sedentary life by regular exercise or sport will have a considerably larger vital capacity than an individual of the same size and weight living an inactive life. He bases his tables upon measurements of body weight, length of trunk, circumference of chest and vital capacity. (See page 65.)

Hartwell and Tweedy[22] studied fifty-four adult women, finding an average respiratory rate of 20.5 per minute before exercise and

28.5 per minute after exercise. The athletic group of women following exercise had an average of three respirations less per minute than the non-athletic group. The exercise was stair-climbing 37 feet, in approximately 45 seconds. These women respired 8.05 liters per minute before and 28 liters per minute after exercise.

Haldane, Meekins and Priestly[23] found shallow breathing caused uneven ventilation of the lungs. Hough,[24] found moderately vigorous exercise decreased the CO_2 alveolar tension and increased the O tension. These changes favor the rapid diffusion of gases from and into the blood. The slow excretion of the muscular catabolites stimulates respiration. The CO_2 output is increased rapidly with vigorous exercise. Waller's[25] study of two lieutenants marching round a circular track showed a CO_2 output of 18 cubic centimeters per second at 4.03 miles per hour, at 7.20 miles per hour the Co_2 output had increased to 52 cubic centimeters per second. The other officer increased from 17 to 57 cubic centimeters of CO_2 output under similar conditions. In dyspnea increasing the depth of the respiration is more efficient and less fatiguing than increasing the rate. This increase in depth also assists the heart by decreasing intra-thoracic pressure and increasing intra-abdominal pressure. The respiratory movements act as a suction pump above the diaphragm and a pressure below the diaphragm. These pressure changes give definite mechanical aid to the heart in cardiac affections. Both inspiration and expiration should be increased in depth in proportion to the mechanical stimulation needed. This increased mechanical aid of respiration may come involuntarily through vigorous exercise of the legs as cited above with the lieutenants or through voluntary increase of the respiratory depth in connection with graded gymnastic movements.

From the lung and heart side the physical improvement of the individual depends on the rapidity of oxygenation of the blood. This in turn depends upon the number of red corpuscles and the amount of hemoglobin in them. These corpuscles are estimated to number 250,000,000,000,000. Roughly one-sixtieth of these are destroyed daily. It is an interesting coincidence that sixty days represents in a general way the time needed to condition college athletes. Training probably increases the rate of destruction of old corpuscles and gives a new group with larger oxygen carrying capacity.

The white corpuscles, numbering 5,000 to 7,000 per cubic mm. of blood, increase during exercise. This increase aids in the protection from pathogenic bacteria and in metabolic processes.

Hawk's[26] experiments show a material increase of both red and white corpuscles in the peripheral circulation following exercise. This increase is probably due to the transfer from other areas to the peripheral circulation.

The amount of blood in the body is approximately 4.9 per cent. of body weight or one-twentieth. In fat persons this proportion may sink to one-thirtieth. This probably explains in part the cause of fat people being so short winded. People over forty are more likely to be fat. In addition the vital capacity decreases through inactivity.

NEUROMUSCULAR MECHANISM.

The body is moved in space and kept in contact with its environment through the skeletal muscles. Muscular activity of the skeletal muscles is a prominent factor in keeping up the tone of the unstriped muscles in arterial and intestinal walls. These muscles in alternate contractions mechanically massage the abdominal organs assisting both circulation and metabolism. The size of the brain cortex areas are related not to bulk of muscle but to complexity of movement. The big muscle group in trunk and legs have relatively small cortical areas while the finger, tongue and eye areas are relatively very large. The neural control of these big muscle areas is less fatiguing than the control of the small areas which require more complex movements.

All persons over forty should keep up a normal control of their neuromuscular mechanism. Nervous instability is related in part to overuse of the smaller neuromuscular mechanism and under use of the big muscle group. From the neural standpoint the failure may come at various points along the line. Loss of idiodynamic control means loss of function in the ventral gray column cells of the spinal cord (ventro-mesial, dorso-mesial, ventro-lateral and dorso-lateral columns). Stimuli from these cells keep up the normal irritability and health of the muscle fibers. Functional failure of these cells leads to muscular degeneration. The dorsal root ganglion cells furnish stimuli which aid in keeping

up normal muscle tone. The cerebellum also assists in this work. The equilibrium of the body both at rest and in motion is regulated through influences coming to them from the internal ear, particularly the ampullæ of the semicircular canals. The nervous influences affecting the synergic or power control of muscles come chiefly from the cerebellum. The cerebellum in turn receives impulses from the visual, sensory and auditory brain areas which influence this power control.

Voluntary muscle movements largely emphasized at present are in the accessory muscle groups of eye and hand rather than the fundamental group of leg and trunk. These accessory groups require large nervous output compared with leg and trunk group.

The vegetative processes are under the control of the sympathetic nervous system, though afferent sensory stimuli going from the splanchnic cells to the central nervous system influence voluntary acts. The trapezius, sterno-cleido-mastoid and facial muscles are among the few to receive splanchnic motor impulses through the spinal accessory nerve. Physicians have long connected these muscle attitudes with fear, anxiety and fatigue without seeing their direct anatomical connection with the sympathetic system. Athletic coaches have shown great skill in recognizing through these facial and bodily attitudes the present potential power and physical efficiency of their charges.

"All or None" Contractions. Keith Lucas[27] in 1905-1909 demonstrated that the "all or none theory" of muscle contraction applied not only to the heart but to the skeletal muscles. Most people over forty use but few of the muscle fibers particularly in the large leg and trunk muscles. This lack of use leading to loss of muscle tone is definitely related to increase in nervous irritability. Loss in muscle tone of the abdominal muscles is related to enlargement of the inguinal rings, particularly indirect inguinal hernias. A similar loss of tone is seen in pronated feet. The drooping shoulders, depressed chest, and protruding abdomen represent loss of muscle tone in the groups of muscles related to posture. Exercises to improve posture and muscle tone must have concentric and static contractions strong enough to shorten long muscles and stretch short muscles. New muscle habits are more easily learned if the contractions are vigorous and static.

The muscular contraction should continue long enough for the patient to appreciate definitely the new corrected position which

has been obtained. Education of these unused fibers may be a real factor in reducing fatigue. This is well illustrated in the wider use of the erector spinal and abdominal muscle group; when muscle tone is good there is less muscle slack and less tendency to either bad posture or muscle and joint strains.

BASIS OF SELECTION OF EXERCISE FOR AVERAGE INDIVIDUALS.

Neuromuscular Skill. Interest in the physical activity pursued is essential to secure the best results from the exercise. Interest increases the strength of individual contraction and makes easier the continuance of beneficial exercise. For this reason, it is important that the youth of both sexes be taught a wide variety of pleasurable exercises and games. The persons over forty who must do merely disagreeable and monotonous exercises because during youth they failed to secure a moderate degree of skill are unfortunate.

Correct postural habits should have been formed during youth. Unfortunately many have never formed good postural habits. Under such conditions, the first essential is definite instruction in correct posture. These exercises will be given in the last section. These exercises for the average person over forty ought not to take more than five to ten minutes per day. After good sitting, standing and walking habits have been formed, three minutes of tuning up exercises each morning will suffice for the postural work. A gentleman eighty-one years old told me recently that he found in his old age he needed less exercise than in his younger days but what he did need was more essential to his physical well being than the earlier larger dose.

Organic Activity. In addition to good posture, which gives room for normal functional activity of the organs above and below the diaphragm, it is essential that the big trunk and leg muscles be used vigorously enough to stimulate circulation, respiration and metabolism.

A fair minority of persons apparently keep healthy without special attention to muscular exercise. Most persons, however, keep in better health with moderate exercise. Some deposit in their health bank small daily deposits, others make their deposits largely at week ends, still others give blocks of time during the fishing, hunting or summer vacation period.

The essential fact to impress on patients is the necessity of making sufficient deposits to have ample reserves for health emergencies. In selection of the physical types of exercise prescribed, consideration should be given, (a) to the physical condition of the patient, (b) to his previous experience in physical activity, particularly during youth, (c) to personal interest in various forms of physical activity.

Previous experience may guide in the selection of the kinds of most interest to the patient. If a person has had little or no experience in physical activity, it is essential that the patient be put under a tutor to guide in the selection of exercises and in the dosage. Definite activity interests will assist a patient in taking the exercise. Patients who are fatigued nervously require a definite positive prescription which gives not only the amount and character of the exercise but the definite time at which it is to be done. Indefiniteness in exercise prescription weakens the faith in them. Few ill people have will power enough to follow general suggestions unless they also have specific things to do. After giving a definite exercise prescription, check up and see that the prescription is followed. Patients' physical interests may lead to the following wide variety of prescriptions.

Gardening may furnish exercise of moderate vigor which can be graded. Fishing and hunting require tramping and climbing. Hiking, combined with nature study and photography are good forms of exercise. Golf demands exercise of moderate vigor. These exercises should not ordinarily be prescribed unless the patient has either had previous experience with them, or can be put under an enthusiastic, patient tutor. Volley ball and indoor baseball with the large soft ball give many men over forty vigorous exercise two to three times per week. These games at the Y.M.C.A. or club-house furnish exercise and social fellowship which leads men to forget business cares. Handball and tennis have the advantage of giving vigorous exercise and requiring but two men for the game. Swimming allows either moderate or vigorous exercise with the additional tonic of the water on the skin. Snow-shoeing, skating, curling and skiing in northern climates furnish exhilarating forms of exercise. Most of these sports and games can be played equally well by women if they have had early training. Women are particularly fond of swimming. They stand cold water better than men because of the larger

amount of adipose tissue.   Dancing, particularly gymnastic and folk dancing with their broad rhythmic movements, is a healthful form of exercise for both men and women.   The social forms of dancing have less value because of the limited muscular action involved.   Cycling with a medium gear furnishes large muscular dosage at comparatively low neural cost.   The gear should be lower if the territory covered is hilly.   These general suggestions are given for people without organic or postural defects who are beginning to lose their former physical efficiency.   The average person needs a minimum of an hour of big muscular activity at least three times per week.   Failure to get this amount of exercise in any week should be made up by additional exercise in later weeks.   This exercise should be supplemented by three minutes of postural tuning up exercises in the morning.

The racially old activities of walking, running, throwing and climbing are fundamental.   They are less fatiguing than the more complicated movements.   Billiards, pool, checkers, chess and such games have recreational value but exert no positive influence on circulation, respiration and metabolism.

Physical Efficiency Tests.   Objective tests show the physical ability of the individual in running, jumping and exercises of skill and strength.   Organic tests show the effect of activity on the organism. . These tests may be structural or functional, or a combination of both.   Dreyer's[21] test outlined in his book, The Assessment of Physical Fitness, gives a combination of structural and functional tests.   Weight, sitting height, circumference of chest and vital capacity are the measurements used.   Dr. Charles Mayo,[28] of Rochester, says of this test, "Dr. Georges Dreyer has shown that the estimation of vital capacity is more than a mere test, that it indicates the tendency to health and resistance to disease, and that in a prognosis of life's duraion, it parallels very closely the results of a general examination."

The weight is computed by adding the weight derived from the length of trunk table to the weight given in the circumference of chest table and dividing this by two, *e.g.*, actual weight, 152.13; calculated weight from trunk length, 135.35 pounds; calculated weight from chest circumference, 137.99 or 135.35 plus 137.99 divided by 2 equal 136.67 weight as calculated. 152.12 minus 136.67 equals 15.46 pounds, or the amount of over-weight.   The vital capacity is determined by adding from the table the vital capacity

corresponding to the person's trunk length to his vital capacity in the circumference of chest table, and dividing this total by two. Dreyer with these tests divides all people into three classes. Class A represents those physically fit and includes in general army and navy personnel, active sportsmen, policemen, firemen, blacksmiths, etc.   Class B includes, in general, second-grade people: doctors, lawyers, business men, high grade mechanics.   Class C includes in general: tailors, shopkeepers, clerks, janitors, etc. These represent the poorest class as a rule in physical efficiency.

Adults may improve their health rating on this test by care in diet, sleep and exercise.   The tables will probably need revision as they are more generally used.   They afford at present the best index of function and structural capacity available to the average physician.

Cardiovascular Tests.   The simplest test is the difference in heart rate between the lying and standing position.   The heart rate standing ought not to increase more than twenty beats above the lying position.   The ordinary increase in the trained athlete is not more than 4 to 10 beats per minute.   Persons in poor condition often show an increase of twenty-five to thirty-five beats on rising from the lying position after the increase caused by the exercise of getting up has subsided.

An elementary test is often given of cardiovascular stability following a standard exercise.   One often used is knee raising. The thighs are raised to the horizontal plane twenty times (each thigh ten times) in ten seconds.   The pulse following this exercise should not increase more than twenty-five to thirty beats.   It should return to normal inside of two minutes.   The author personally took this test following the writing of the preceding statement and found a normal standing pulse of 78, a pulse after the exercise of 92, or an increase of 14 beats, based on the first half minute after exercise.   The pulse returned to normal in less than two minutes.

The essentials in a good cardiovascular mechanism are a low heart rate both lying and standing, a small increase after exercise, and a rapid return to normal following exercise.   The well-trained person often has a pulse below normal five minutes after exercise, which persists for twenty minutes to an hour following the exercise, the length of the subnormal phase depending on the vigor of the exercise.

More complicated tests of physical efficiency have been given the aviators by Schneider.[29]   This scheme is now in use by the flight surgeons at Mitchel aviation field on Long Island.   These tests add blood-pressure as a part of the examination.   I quote a section from his article which gives a description of the scheme used.

"The scoring scheme we have used recognizes that fatigue or derangement may be evidenced in the high heart rate during reclining, during standing; in the number of beats the heart rate increases when the standing and reclining postures are compared; in the acceleration in the pulse rate after exercise; in the time taken by the pulse to return to normal, and, lastly, in the rise or fall in the systolic blood pressure on standing.   This scheme uses in part a plan proposed by Dr. J. H. McCurdy for rating infantry men in cardiovascular and neuromuscular efficiency.   The score for each of the six items range from + 3 to — 3.   A perfect score, the sum of the value given to each of the six items, is 18.   The values as assigned appear in Table 1, Parts A B C D E and F.   In using the table for scoring Part A and B, also C and D must always be used together.   Thus, if an individual has a pulse rate increase of 15 beats (see Part B) on standing and his reclining rate was 60 (see Part A), he is graded 3 on his standing increase.   However, if his reclining rate had been 100, then a standing increase of 15 would have been scored 0.

PROCEDURE IN MAKING OBSERVATIONS.

"1. The patient reclines for five minutes.   (a) The heart rate is then counted for twenty seconds.   When two consecutive twenty second counts are the same, this is multiplied by 3 and recorded.   The score is noted according to Part A, Table 1.   (b) The systolic blood pressure is next taken by auscultation; two or three readings are made as a check.

"2. (a) The patient stands at ease for one or two minutes to allow the pulse rate to assume a uniform rate.   When two consecutive twenty second counts are the same, this is multiplied by 3 and recorded.   The score is obtained by use of Part C, Table 1. The difference between the standing and reclining pulse rate is scored then by use of Part B, Table 1.   (b) The standing systolic pressure is next taken.   The difference between this and the reclining systolic pressure is then scored by Part F, Table 1.

TABLE 1. POINTS FOR GRADING CARDIOVASCULAR CHANGES.

A—Reclining pulse rate.		B—Pulse rate increase on standing.				
Rate	Points	0—10 Beats Points	11—18 Beats Points	19—26 Beats Points	27—34 Beats Points	35—42 Beats Points
50—60	3	3	3	2	1	0
61—70	3	3	2	1	0	—1
71—80	2	3	2	0	—1	—2
81—90	1	2	1	—1	—2	—3
91—100	0	1	0	—2	—3	—3
101—110	—1	0	—1	—3	—3	—3

C—Standing pulse rate		D—Pulse rate increase immediately after exercise.				
Rate	Points	0—10 Beats Points	11—20 Beats Points	21—30 Beats Points	31—40 Beats Points	41—50 Beats Points
60—70	3	3	3	2	1	0
71—80	3	3	2	1	0	0
81—90	2	3	2	1	0	—1
91—100	1	2	1	0	—1	—2
101—110	1	1	0	—1	—2	—3
111—120	0	1	—1	—2	—3	—3
121—130	0	0	—2	—3	—3	—3
131—140	—1	0	—3	—3	—3	—3

E—Return of pulse rate to standing normal after exercise.		F—Systolic pressure, standing, compared with reclining.	
Seconds	Points	Change in Mn.	Points
0—60	3	Rise of 8 or more	3
61—90	2	Rise of 2—7	2
91—120	1	No rise	1
After 120: 2-10 beats above normal	0	Fall of 2—5	0
After 120: 11-30 beats above normal	1	Fall of 6 or more	—1

"3. The patient next steps on a chair about 18 inches high five times in fifteen seconds, timed by a watch. To make this test uniform, he stands with one foot on the chair and is not brought to the floor again until after the count five. At each count he brings the other foot on the chair and at the count "down" replaces it on the floor. This should be timed accurately, so that at the fifteen second mark both feet are on the floor. (*a*) Immediately, while

he stands at ease, the pulse rate is counted for fifteen seconds; this is multiplied by 4 and recorded. (*b*) Counting is continued in fifteen second intervals for two minutes, record being made of the counts at 60, 90 and 120 seconds.

"The data from (*a*) will be scored by Part D, Table 1, taking the difference between this exercise pulse rate and the standing rate. The data in (*b*) are scored according to Part E, Table 1.

"This system of scoring men as to physical fitness is now being used by flight surgeons in their work among aviators, and is applied at the medical research laboratory at Mitchel aviation field on Long Island. That there may be value in assembling the circulatory data under such a point system is indicated from an analysis of fifty-four cases of aviators who, when examined by the medical officers of the departments of the laboratory, were found to be ailing and physically below standard. The medical examinations included an overhaul by the internist, neurologist, ophthalmologist, and ear, nose and throat expert. The medical findings include a large variety of conditions, the majority being common to any group of men and in no way characteristic of aviators.

"Only six of the fifty-four cases had a score of 10 or better, while 88.8 per cent. had scores ranging between 8 and —1. These figures seem to indicate that a score of 9 or less is characteristic of physically unfit men."

The exercise of stepping on a chair eighteen inches high is not as good an exercise as the knee raising described above, for raising the heart rate.

Neuromuscular Tests. Standing without swaying for half a minute with the eyes closed and the feet six inches apart is a good elementary test of muscular sense and control. Standing without swaying for half a minute with eyes closed and the feet together, *i.e.,* both heels and big toes touching, is slightly more difficult. Standing without swaying for half a minute on one foot with eyes closed and with the opposite leg held stationary in the knee raised position requires good muscular control.

Putting on and taking off the shoes without leaning against some support as an aid shows good control. Walking on the railroad rails for thirty feet without losing the balance shows good control. The ordinary walking beam also provides a similar chance for testing motor control.

SPECIAL TYPES OF EXERCISE.

Correction of Faulty Antero-spinal Postural Habits.

1. Round Shoulders.

    (*A*) Standing Exercises.

    (1) Hands on head—place! position! (Fig. 1.)

    (2) Hands on forehead—place—position! (Fig. 2.)

    (3) Hands on neck—place—position! (Fig. 3.)

    (4) Elbows sideward bend—position! (Fig. 4.)

    (5) Arms bend—downward stretch! (Fig. 5.)

Fig. 1.   Fig. 2.

    (6) Hands upward raise—sink! (Fig. 6.)

    (7) Elbows half sideward bend—sink! (Fig. 7.)

    (8) Elbows half sideward upward bend—sink! (Fig. 8.)

        These exercises may be combined by changing from one position to another, or by passing through the bend stand position. · (Fig. 5.) They may also be combined with trunk bending, thus increasing the work as the patient improves. Still greater dosage may be given by adding forward charging to these exercises. (Fig. 13.) Repeat exercises five to twenty times.

    (*B*) Prone Exercises, on plinth or bench, such as is used in the ordinary gymnasium in front of the stall-bars.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

(1) On plinth, head upward bend—sink!
(2) On plinth, hands on neck place—sink!
(3) On plinth, hands on hips place—sink!
(4) On plinth, arms bend—downward sink!
(5) On plinth, arms upward stretch, sink!
(6) On plinth, hands upward raise—sink!
(7) On plinth, elbows sideward bend!
(8) On plinth, elbows half sideward bend—sink!
(9) On plinth, elbows half sideward upward bend—sink!

Fig. 8.   Fig. 9.

(10) Mechanical forward upward raising of arms by operator.
     In all of these positions, keep flat the lower back. Avoid
     lordosis. Prevent lordosis in these exercises by fixing
     the dorsal spine with straps, or by holding.

(C) Sitting Exercises, on bench or plinth, with toes beneath
    a round of the stall-bars.

(1) Trunk backward bend—upward raise! Support the lower
    abdomen with hands.

(2) Trunk backward downward bend—upward raise!

(3) to (13) Repeat exercises in Prone series on the plinth,
    (1) to (10) inclusive.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

(14) Trunk to left twist! Trunk backward bend! Trunk
         upward raise! Trunk forward twist!
(15) Same exercise on right side.
(16) Trunk circling, beginning with sideward bending.

2. Pronated and Flat Feet.
    (*A*) Resistance Exercises, lying on couch.
    (1) Adduction of the foot against resistance by the operator.
         Patient should be carefully taught to give full adduction
    (2) Flexion of the foot, gradually increasing the resistance.

Fig. 14.

Fig. 15.

(*B*) Active Exercises.
(1) In sitting posture.
    (*a*) Extension of knee, keeping ball of foot and heel on the
           floor.
    (*b*) Repeat, with adduction.
    (*c*) Repeat, with supination, raising the inside of the ball
           of the foot.
    (*d*) Picking up marbles with toes, with leg in vertical posi-
           tion and later in extended position.
(2) Walking and standing exercises.
    (*a*) Alternate toe touching, forward on count. Require pa-
           tient to stand well on the outside of the standing foot,

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

and to extend the other foot well forward, reaching
with the toes.   (Fig. 10.)

(*b*) Alternate toe touching, with heel raising on both heels.

(*c*) Heel raising, in pigeon-toed position, on count.   Require
patient to hold the counts, that operator may see that
good posture is maintained.

(*d*) Forward on count, march!

(*e*) Walking on outside of feet, pressing upon the ball of
the foot first.

Fig. 20.   Fig. 21.

(*f*) Forward on the balls of the feet in rhythm, march!

(*g*) Knee bending, keeping feet in supinated position.

(*h*) Walk with inversion of the foot, on boards tipped down
on the outside, 10 to 15 degrees.

(*i*) Walk with adduction and inversion of the foot on hori-
zontal ladder, with front stop and foot rest which in-
verts the foot about 10 degrees.

(*j*) Walk with adduction of the foot, shoving outside of the
foot hard against horizontal ladder, rungs of ladder
placed on floor.   Swing the outside of the heel close
to the ladder rung.

These last three exercises represent the essential exercises in Barron's exercises which were used in the English Army and are at present being used in the Naval Hospital at Brooklyn and other places in this country.

3. Cardiac Irregularities.

Use exercises listed under General Exercises for persons over 40, increasing the amount as indicated by cardiovascular tests already given.

4. Constipation.
   (1) Lying on back.
      (*a*) With knees bent, raise legs alternately.
      (*b*) Same, raising both legs together.
      (*c*) With knees straight, raise legs alternately
      (*d*) With knees straight, raise both legs simultaneously.
      (*e*) Repeat exercises (*a*) to (*d*) inclusive, grasping knees and pressing them against abdomen.
      (*f*) Raise trunk to sitting position, using elbows to assist at first.

   (2) Standing position.
      (*a*) Knee raising.   (Fig. 10.)
      (*b*) Trunk forward, downward bending.   (Fig. 11.)
      (*c*) Trunk sideward bending.   (Fig. 12.)
      (*d*) Forward charging.   (Fig. 13.)
      (*e*) Sideward charging.   (Fig. 14.)
      (*f*) Backward charging.   (Fig. 15.)
      (*g*) Backward oblique charging.   (Fig. 16.)
      (*h*) Trunk forward downward balance position.   (Fig. 17.)
      (*i*) Trunk sideward downward balance position.   (Fig. 18.)
         The last two exercises are considerably more difficult than the rest of the series.

GENERAL EXERCISES FOR PERSONS OVER FORTY.

Morning Exercises with Bath and Rub.

Five minutes of well-selected exercises followed by bath and rub, will do wonders.

1. Postural tuning up.
   (a) Stand on outside of feet, on toes, with feet parallel, press-
       ing knees outward, contract vigorously muscles of feet
       and legs.
   (b) Knee bending in first position, going one-fourth to one-
       half way down, depending on strength. (Fig. 19.)
   (c) Contraction of abdominal muscles, flatten and draw up-
       ward lower abdomen.
   (d) Neck grasping, keeping elbows and neck back as far as
       possible. (Fig. 3.)
   (e) Arm bending with rotation of arms backward and out-
       ward, contract vigorously the muscles which flatten the
       upper back. (Fig. 5.)
   (f) Knee raising, twenty times. (Fig. 20.)
   (g) Running in place, twenty times.
       The first five exercises should be done from five to ten times.

2. Lying position. This series will take a second five minutes.
   (a) Knee raising, twenty times. (Fig. 10.)
   (b) Knee raising, clasping knee and pulling it close to abdo-
       men twenty times.
   (c) Leg raising with knee straight twenty times. (Fig. 21.)
   (d) Raise head and shoulders ten times using elbows to assist
       at first.
   (e) Raise trunk to sitting position keeping back flat. Use
       elbows and hands to assist at first.

In addition to these two series of exercises, individuals will
find real profit in group exercises for half an hour three times
per week with some congenial companions. Volleyball, handball,
tennis, squash, skating, tramping, riding and swimming are good
illustrations of big muscle activity. These activities should be
limited in amount and vigor to the dosage which will leave the
individual fit for business the next day.

Loss of vigor may come from either too little or too much
exercise. Few persons get enough total exercise for the week.
Some persons do too much when they exercise irregularly, though
the total amount per week or month is very small. Regularity in
diet, sleep and exercise are essential to continued efficiency.

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Occupation and Diseases of Middle Life

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Occupation and Diseases of Middle Life.

> God lent his creatures light and air
> And waters open to the skies;
> Man locks him in a stifling lair,
> And wonders why his brother dies.
> —Oliver Wendell Holmes.

The activities of life divide society into three parts: *Producers,
agents* and *consumers.* The first make more than they them-
selves use up, and are represented by the hands in factories,
mills, mines, on farms, etc. The second are necessary to keep
products on the move, and are represented by officials, merchants,
dealers, overseers and the like. The third are composed of the
first two groups, plus a fair percentage of independents, and at
present an *over-weight of dependents.*

Two things in the above mentioned delineation concern us,
(1) the age groupings and (2) the character of a large part of the
"over-weight." Statistical evidence, collected widely throughout
the country, shows that the army of producers is replete with
persons under forty years of age, and the thought at once arises,
what becomes of them after that age? Investigation shows that
most have joined the third class, the consumers, and, we are sorry
to observe, very often as dependents. They have reached this
dependent class through many agencies, but the chief, we submit,
is industrial strain and mishap, results of which are with us to-
day as a large army of debilitated and, for the most part, unem-
ployable. Excuses such as moral hazards, defective heredity,
and preventable diseases are always put prominently to the front,
but even in these how much of a factor has industrial stress been?

The producer's reward should be independence in later life.
There are different kinds of independence. For instance, we
would not imply that those whose wordly goods had gone to the
commendable rearing of families should be classed as dependents

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in any sense at any time, but, with all persons, *debility-depen-dency* should begin well after 60 years and not after 40.

Dr. Tatham says that "the forty years between the twenty-sixth and sixty-fifth birthdays mark the period of life during which the effects of occupation are most conspicuous." When one considers the various types of individuals, possessed of various physical qualifications who enter our various occupations to elaborate the necessities and utilities of life for all of us, the substance of his statement is appreciated and we wonder only whether the basic reasons can be grasped and the effects properly adjudicated.

To my mind, hygiene is the keystone of efficiency and production. It covers the relation between man and his environment; or, more strictly speaking, between physiology and concrete facts. Industrial hygiene, of itself, covers (1) the state of perfection of sanitary equipment in the plant—this is *factory sanitation;* (2) the *state of physiologic perfection* of the worker—this is dependent upon information collected by means of physical examinations; and (3) the extent of knowledge and practice of *personal hygiene*—this is conservation of health and energies, and is controlled by both employer and employee. It is only by a well-coördinated interaction between these three fundamentals that industrial application may stand for efficiency, production and happiness, rather than for inefficiency, loss and suffering.

For the present discussion the writer draws principally upon two sources of information: The vital statistics (particularly those dealing with insurance experiences, and with the U. S. Census) and upon his own investigations published largely in official reports, such as the Survey of Industrial Health Hazards and Occupational Diseases in Ohio (Ohio State Board of Health). Of the three factors above stated which enter into the ultimate health aspects of an occupation, the writer will dwell especially upon the first in an endeavor to point out those demands of a "job" which may endanger health, especially in the long run. The expressive term "industrial health hazard," covers the idea.

An *industrial health-hazard* may be defined as any condition or manner of working which is unnatural to the physiology of the human being so engaged. This physiology is adaptable to quite wide variations in environment, but the rule holds absolute that the subjection to conditions which are unnatural to the physiology and habits of man results in pathology or disease.

There is nothing strange or new, as a rule, about these hazards, but a proper conception of them is a necessary foundation. Industrial health-hazards are listed, thus:

I.	Fatigue.	V.	Humidity.
II.	Infections.	VI.	Temperature.
III.	Dust.	VII.	Illumination.
IV.	Ventilation.	VIII.	Poisons.
	IX.	Miscellaneous.	

As an aftermath to the above, it is necessary to mention *industrial stimulatism* which is usually alcoholism, coffeeism, or drugism. This stimulantism is promoted often by the conditions of work such as the subjection to one or more of the above health-hazards; or, because of the absence of good drinking water; or, because of a tradition among workers in certain lines that alcoholic liquors tend to stimulate them and to protect them from the effects of poisons, dusts, gases, or hard work to which they may be submitted; or to the fact that some employers in the past have promoted alcoholism among their workmen by permitting the drinking of intoxicating liquors while at work, and, finally, to the fact that there is an absence of a real industrial efficiency department in connection with an establishment which takes cognizance of the welfare of the human element as part of the required upkeep for the success of the business.

The second most important feature in the relationship between work and disease is the problem of *the worker himself*. Some workers are very much more susceptible to the health-hazards mentioned above than are others, so much so that as hygienic as certain industries and processes can possibly be made, still there are certain classes of persons who should not engage in them. This is exemplified today, in many instances, as a matter of natural selection; for instance, the more delicate and sickly-disposed persons do not follow the more fatiguing or heat-exposing trades. Unfortunately this does not apply so closely to older workers who have been following the more hazardous undertakings for years, and who having become weakened from various causes, still endeavor to remain at their chosen vocations, irrespective of the damaging effects upon the body. Most of this question of the variability in the human factor will be solved in the 'future by the placement and adjustment of employes

through medical supervision to meet their varying physical ca-
pacities. As an economic principle this must be done for the
benefit of employer, employe and consumer.

A third feature requiring discussion is that of a false concep-
tion of *adaptation* or habituation, *i.e.,* the being able to "get used
to" the various health-hazards. This, many times, is a defense
put up by employers, and even by employes for taking various
health risks. It has some substance when superficially considered.
For instance, the newly apprenticed barber soon gets used to the
discomfort, pain and stiffness which first appears in the hand
and arm using the scissors; the baseball player soon gets used to
the muscular effort required in throwing the ball in the spring
practices, and is no longer inconvenienced by soreness, stiffness,
etc. Here fatigue is the factor concerned, and it is well known
that what proves to be fatiguing to a person today may be per-
formed at perfect ease after a few days of experience. This is
because a physiological adjustment has taken place in which more
blood, a better circulation and an improved nerve control are
established in the parts used. Perhaps a fatigue antitoxin is
developed to protect the body from a fatigue toxin. Since this
is a physiological result, it must be considered perfectly normal.
In other words, what was primarily fatigue, therefore a health-
hazard, has, by a natural adaptation, become no longer fatigue. It
is a phenomenon within the boundaries of physiology.

The vital point is: How far can such physiological adaptations
take place without ultimate damage to the organism? We may
state it as fundamental, that outside of the adaptation cited for
fatigue, none of the health-hazards can be "gotten used to."
We mean accustomed to, in a physiologic, and therefore a normal
manner. No person can become habituated to an existence in a
damp, dark, or ill-aired place. Nor again to the inhalation of
certain dusts, to a constant exposure to high temperature, nor to
sudden changes in temperatures. The physiologic mechanisms
of the human body are not capable of adapting themselves to the
conservation of health and vitality in the continued presence of
such hazards.

The subjection to poison (other than toxins—that is, biologic
poisons) is absolutely incompatible with health and a normal span
of life. It is commonly thought, for instance, that a person can
soon become habituated to the inhalation of benzine fumes, so

that the intoxicating effects, producing giddiness, dizziness, a feeling of elation and loquaciousness, experienced during the first week or so of exposure, but which, as a rule, pass off thereafter, have been "gotten used to." This is an erroneous idea. Apply the same argument to alcohol. Simply because it may take more to get the chronic toper intoxicated is no proof that he has become habituated because of a physiological re-enforcement. He has simply become tolerant by digging into his reserve. There is a vast difference between toleration and the physiologic normal. Toleration lasts only so long as the extra powers, with which all vital organs are endowed, can meet and compensate for the oppression. For instance it has been shown that as little as one-twenty-fourth part of the normal amount of kidney substance will maintain life in the individual and, in a similar way, other organs and parts of the body are superiorly equipped. But the utilization of physiological functions to their limits of reserve capacity is abnormal and unnatural, and a transgression of natural laws results in diasaster. This is just as true of physiology as it is of physics. Hence toleration of unnatural environmental conditions which many persons look upon as "getting used to" situations is untenable, and will finally result in health entanglements if not in disease, invalidism, and untimely death.

So much for the individual. Let us now look at the composite results in the mass: At the Fifth Annual Conference of the American Association of Industrial Physicians and Surgeons (held in New Orleans, April 26 and 27, 1920), it was estimated that $100,000,000 under the physician's signature was spent annually in the United States for the care of injured (including sick) workmen, an estimate previously made by Dr. Otto P. Geier. The subsequent discussion brought out the opinion that this figure was very conservative. Professor E. L. Collis, in Great Britain[1] analyzed the "debit and credit" side for industrial medicine in that country and summarized as follows: "The proposition is put forward that industrial medicine properly applied can effect a saving each year on labour turnovers of from 50 to 70 millions, on lost time of 50 to 60 millions, and through industrial convalescence of many millions more. Put the total at £140,000,000 on a conservative estimate. There are today something over 40,000 doctors in the kingdom; the cost, if industry employed half the profession and gave each doctor £2000 a year for whole-time

work, would amount to £40,000,000 a year, leaving a handsome balance of £100,000,000 a year. Such wholesale engagement of the profession is not proposed, and indeed is not needed. The figures are only instanced to demonstrate that industry by developing industrial medicine has the promise of great profit while it fulfills a great social service."

It seems the certificated convalescent in Great Britain under the Compensation Act, is not allowed to work. Upon this point Prof. Collis says: "Convalescence can be expedited both mentally and physically by graduated activity of an interesting nature, and the best form of interest is remuneration for work done, which is today precisely the form of activity prohibited for the industrial convalescent. The result is that today enormous sums of money, which there are no means for estimating accurately, are expended in retarding convalescence."

THE INDUSTRIAL HEALTH HAZARDS AND THE MIDDLE AGED WORKER.

FATIGUE.

To understand the reasons for the prevalence of fatigue in industry we must look into the factors which underlie fatigue. These are of two general types: (1) *Intrinsic,* or pertaining to the individual himself and discovered by physical examinations, including a past sickness history, subjective symptoms, etc.; and (2) *extrinsic,* or immediately associated with the conditions of work. The extrinsic are discovered by an analysis of the given job and its environments.

The *chief intrinsic* or *personal factors* entering into *fatigue* are as follows:

(1) Food, its nutritional, energizing and vitaminous character, and the hygiene of digestion and the digestive tract.

(2) Oxygenation of the food in the tissues, judged indirectly by the presence or absence of anemia.

(3) Circulation efficiency (cardiovascular status).

(4) Eliminative efficiency (the intestines, kidneys, lungs and skin).

(5) Disease conditions present (especially chronic infective foci of teeth, tonsils, gall-bladder, appendix, lungs, accessory nasal sinuses, etc.),

(6) Abuse of stimulants and depressants (coffee, tea, alcohol, drugs, highly spiced foods, hot drinks, etc.) which (1) decrease the reserve capacity, (2) are often substituted by the worker for meals, and (3) benumb the sense of fatigue. Man needs a stimulant but the normal physiological stimulant is to be regarded as the adrenin produced by one's own glands.

(7) Lack of industrial interest; often engendered by anxiety and worry over outside affairs. Interest in the task at hand is undoubtedly the psychological stimulant for the production of adrenin, and therefore greater physical and mental effort.

(8) Lack of skill. Newness to any work always causes a surprising amount of fatigue. Adaptation and skill soon overcome this, provided a stable nervous system be present. In the acquisition of true skill the avoidance of useless movements and strained postures is especially to be aimed at.

(9) Amount of rest. Defining rest as a state of relaxation between work efforts it is probably true that most work permits enough rest periods interspersed with effort periods to suffice. Some occupations do not. While Taylor[2] found that in the operation of carrying pig iron, rest periods should occupy fifty-seven per cent. of the time and actual work only forty-three per cent., all strenuous labor has optimums which are capable of discovery for the average worker by putting him on his own volition with a prize incentive (piece-work, etc.). In general, rest periods should so interrupt work efforts throughout the day as to conserve full capacity and enable one to "quit fresh" instead of "so tired." This is the basis of the military day. It seems a good practical rule that if the meal following a work spell does not fully restore work capacity, then that work has been pathologically fatiguing. In some work, meals or light lunches must needs come every two or three hours.

(10) Amount of sleep. The middle aged worker, who is in normal health, requires about seven hours sleep (always at night time if possible) to meet his requirements. Earlier in life he has required 8 or 9 and he may find that as little as six and one-half or six hours is sufficient as he grows older, although ageing ultimately demands more. Sleep is primarily the "rest period" for the nervous system It is also the opportune time for taking advantage of fresh air breathing which conditions of work so often prevent during the day.

The *extrinsic factors* leading to fatigue are, as a rule, much less important than the intrinsic although often improperly considered the more important. This is because they are so much easier noticed and, also, much more apt to become the cause of complaint. The author goes so far as to say that if all of the factors above listed for the intrinsic cause of fatigue are properly supervised, it is only exceptionally possible to fatigue the human body by the extrinsic factors, *i.e.*, that the factors must have to exist in such plainly hazardous amounts (not necessarily plain to the ignorant) as to preclude much work effort under them.[2]   The chief extrinsic factors may be summed up as follows:

(1) Hard work. This is such a relative term as often to mean little. It has an empirical standing, not often one capable of estimation by scientific procedure or methods of precision. For the present the experience of the work group as interpreted by the trained observer must obtain.

(2) Night work; abnormal to the human being, who is in no sense a nocturnal animal and whose physical prowesses reach a low ebb between the midnight hour and daybreak.

(3) Long hours; again a very relative question but undoubtedly affecting mental workers less than physical workers.

(4) Piece work; a matter of adaptation and of skill and of properly interspersed rest periods—perhaps a rest interval as often as every thirty seconds in some processes. Since it furnishes a goal, it arouses interest, counteracts monotony and substitutes a normal stimulant for what is too often the case, abnormal and harmful stimulants.

(5) Rhythm; a feature which must be studied for, and by, the given worker and which undoubtedly when traversed only encourages the development of neuroses.

(6) Monotony; a purely relative question depending more upon the level of intelligence and ambition of the worker than the class of the work. What is plainly monotonous to one becomes irksome and is soon dropped, but the same process may prove absorbingly sufficient to another.

(7) Distractions; disturbances of all kinds, noise, vibration of floor or building, glaring illumination, interruptions, etc., these take their daily share of attention and, therefore, energy to meet.

(8) Forced inactivity; sedentary work, close eye work, etc.

(9) Forced postures; work requiring continuous fixed attitudes. Requires extra energy, also care in preventing deformities.

(10) Forced standing still; easily solved by providing seats to be used at the option of workers.

(11) Spurious seating; especially detrimental when the incorrect seating causes a slump or kink of the body and a "transverse abdominal crease," or when it interferes with circulation in the limbs. Often corrected by a lower seat or higher work plane. The writer contends that the slump posture is the most restful and requires less energy to maintain, similar to Doctor Amar's statement that the erect standing posture uses more energy as measured by the CO_2 output.

(12) Prolonged strain; this is undoubtedly the most important extrinsic cause of fatigue known and must be obviated by rest interruptions of sufficient time and relaxation to preclude abnormal fatigue substances in the tissue. Otherwise the work day and the output are greatly shortened.

(13) Abnormal ventilation conditions, especially overheated air when stagnant and humid; worse when polluted with noxious gases, fumes or smoke.

(14) Sanitation provisions (toilet, drinking places, and laving places) inconvenient or uninviting; prompts constipation, disuse of water, and personal uncleanliness.

(15) Long distance from home to work place, often with weather exposure; contributes much to the day's toll on the day's energy supply and must be reckoned in as part of the day's work.

Criteria of Fatigue. When do we know that the day's work is fatiguing? There are so many conditions creating the same symptoms of "tiredness" as fatigue that this question is difficult to answer in the individual case. In a group of workers it is easier. Here the criteria are the following:

(1) General complaints of tired feeling at close of work periods.

(2) Many health complaints; requests for time off; too many quittings.

(3) "Fagged" appearance of numbers of workers.

(4) Defective output; not necessarily decreased output except when measured by the week or month.

(5) Lessened desire to work; disloyalty.

(6) More precisely, the evidence, discovered on inspection, that many of the *intrinsic and extrinsic causes of fatigue are present.*[3]

The Effects of Fatigue. We look for the ultimate effects of fatigue in persons approaching midlife and later. Chiefly to be mentioned are: Increased susceptibility to infections, particularly in the respiratory and dermatological systems; rheumatism, both acute and chronic; neurasthenia, associated in certain persons with neuroses (tailor's cramp, etc.), and often-times with hysterical manifestations. It is said that seventy-four per cent. of industrial neuroses occur among expert workers. Frederic S. Lee suggests that, since "pathological fatigue substances" are found in the blood and secretions in diabetes mellitus, there is a strong suspicion that fatigue bears a causal relationship to this disease when it appears in adult life. Cardiac disorders such as "irritable heart" and the so-called "effort syndrome," are cited in early midlife principally when the worker undertakes a more strenuous physical task. A limited degree of anemia is another alleged symptom. Lee emphasizes "borderland ills" in general. Much evidence is reported on the relationship which fatigue bears to the causation of accidents.

One has but to look under the "etiology" of the various diseases discussed in a textbook of medicine to appreciate the oft-repeated statement that fatigue is a predisposing cause of the given disease under consideration. Accumulated fatigue in women is alleged to result in menstrual disorders, constipation, and digestive disturbances. As in overdoing physical culture, girls and women subjected to industrial fatigue are also apt to veer to the masculine type and prove physically less capable of performing the functions of motherhood successfully than their effeminately developed sisters. Statistics show that, between twenty and fifty-five years of age, working women have more illness than men, often losing twice the amount of time from this cause.

The *sequence of events in fatigue* may be summarized thus:

(*a*) Immediate results: Inaccuracy in execution; puttering; decreased enthusiasm followed by decreased morâle; depression; health complaints varying in different workers according to their "weak points." In respect to the output itself there is noted an

increase in defects (and in repairs necessary), although the quantity of output may not be affected.

(*b*) Results in the course of a few days or weeks: Incorrect attitudes both physical and mental; careless output; loitering, often unappreciated by the worker; requests for time off; sick spells affecting different workers according to their most vulnerable points; and, finally, the employment analysis shows an increased labor turnover.

(*c*) Results after years: Workers have changed jobs or dropped their regular trades "for something easier although at less pay;" this is so common that in many industries with trades which should be of life-long tenure, but a comparatively few workers are found over forty and a handful over fifty years of age. Here workers show definite physical deformities varying according to the stresses of their respective occupations, but chief among them are back, shoulders, foot and leg afflictions of musculo-osseous types. A general condition of malnutrition may be present, but not necessarily loss of weight—there may even be a moderate amount of obesity, usually associated with some anemia. Decreased endurance, irritability and changeable dispositions proclaim neurasthenia. They often show signs of premature ageing. They have a marked loss of independence so characteristic of younger years and in its place either desultory, sheeplike submission or a loquacious, gently bluffing nature with no stability. Physical examination invariably shows the presence of chronic diseases (circulatory, kidney, respiratory, etc.).

INFECTIONS.

An outline of the classes of industrial infections will suggest at once the affliction to be expected as life proceeds. The usual industrial infections are due to the following things, all extrinsic:—

1. *Mouthed articles,* as "shuttle kissing" (sucking the thread through the shuttle opening) in the textile industry, passing the blow-pipe along from man to man in the glass industry, and a limited number of similar promiscuous mouthing operations. The whole class of communicable throat and respiratory diseases, syphilis, and the common pyogenic infections are thus open to spread.

2. *Crowded workers.* While most State laws specify the minimum space or cubic feet allowed per worker, oftentimes the mass of workers in a given process (as in machine work, cigar making, etc.) may be closely crowded together in a fractional part of the total room dimensions. All those diseases acquired by "droplet" infection, as from coughing, sneezing, etc., have correspondingly increased opportunities for spread under such conditions.

3. *Short-intervalled handling of articles.* So many industrial processes build up the articles of manufacture by a continuous rapid sequence of operations from worker to worker that the moisture of hand contact left by the one is transferred directly to the hand of the next. As long as hand contact alone obtains, this mode of spread of a communicable disease is usually quite limited, but where the occasional hand goes to the mouth, the nose or the eye, or to the tobacco pouch and thence to the mouth, the case is far different.

4. *Personal conveniences used in common.* Here the industrial list includes the following: Cups, towels, water-pails, wash basins, soap, mouth-contact bubbling fountains or faucets, toilets, bunks, cafeteria, dishware, goggles, gloves, masks, certain articles of clothing, lockers, and perhaps shower baths used by numbers together.

5. *Sweeping or dusting during work hours.* The hazard is probably more by way of the physical irritation by dust particles of the mucous membranes of the respiratory tract, inviting invasion by bacteria locally present, than by any direct transfer of living organisms by the dust.

6. *Moist air.* Steam particles, spray droplets and possibly high humidity favor the direct transference of living bacteria from person to person and of mycosis (aspergillus), molds, etc. to the respiratory tract, skin, ear canals, etc.

7. *Spitting* on floors. Of some hazard in dark, damp or dusty workrooms through aerial convection of germs, but of chief hazard by way of insect vectors.

8. *Insects, vermin,* usually important because germ distributors, but there are to be noted ringworm, scabies, pediculi, and others, which occasionally spread at the work place.

9. *Handling of fatty, and fat absorbing, substances*: Oils, greases, cutting compounds and cleansers.

10. *Handling of infectious materials,* hides, hair, fertilizers, etc.

11. *Workers about animals or meats,* anthrax, glanders, rabies, tetanus, erysipelas, furunculosis, actinomycosis (lumpy jaw), pemphigus, tinea, tubercular warts, cow-pox, foot-and-mouth disease, milk sickness, tapeworm and perhaps plague—nearly all more or less industrial but fortunately rare.

12. *Workers of the soil,* tetanus, malaria, hookworm, gas bacillus infections, and certain tropical afflictions.

13. *Polluted source of factory water supply,* the usual waterborne diseases.

While the *extrinsic* causes of infections above listed occur in all age-groups, they are undoubtedly more common as a rule in those under forty, in whom susceptibility appears to be greater. On the other hand, *intrinsic* infections of latent or chronic character located within the individual (teeth, tonsils, middle ear, nasal sinuses, heart valves, bloodvessels, bronchial glands, lungs, pleura, joints, bile tract, appendix, prostate, bladder and kidneys) are undoubtedly more common after forty and are often awakened into activity by the accumulating effects of work-stress. We see this in the outcropping of tertiary syphilis, of chronic phthisis, increasing attacks of inflammatory rheumatism, etc. The gradual increase of pneumonia with age is accepted, but the high incidence of the disease in all age-group in some workers, as miners, quarriers, heat, gas and weather exposed workers, shows the influence of occupation.

Tuberculosis has nearly twice the mortality rate in males as compared to females for the age-group forty-five to sixty-four years, which Hoffman claims is largely, if not exclusively, the result of health-injurious conditions in industry, enhanced, no doubt by more careless personal habits. The same status holds true to only a slightly less degree for lobar pneumonia. Fisher aptly says, "First fatigue, then colds, then tuberculosis, then death."

DUST.

All air contains dust, although it is usually invisible. Its presence is often detected by special illumination, as the passage of a beam of light through a dark space. Estimations by the most refined methods show counts of from 17,000 (per c.c. of air) upwards in city environments, less in the country, as a rule, and still less over the ocean or at high altitudes. Obviously the in-

tegument of man is good protection against natural dusts almost irrespective of quantity. Likewise the respiratory tract is fully armed, through its moistened, tortuous passages and ciliated epithelia to deal with customary amounts. Indeed, inhaled particulate matter is undoubtedly a chief physiological stimulus to the ciliated epithelium.

Importance of the Subject. It is probably safe to say that to-day over 4,000,000 males and 1,000,000 females are exposed to the industrial dust hazards in the United States. Hoffman's[4] figures based on the 1910 census were only slightly under these estimates. These figures represent over ten per cent. of all workers.

Classification of Dusts.[5] From the point of view of harmfulness as generally accepted dusts may be classified as follows:

(1) *Hardness.*

(*a*) Flour, soot, soft wood, coal, shale, soapstone, bone, horn, shell, ivory, amorphous silica.   .

(*b*) Iron, zinc, brass, copper, cement, chalk, lime, limestone, slag, plaster-of-Paris.

(*c*) Organic dusts, such as hard woods, vegetable fibers, hair, etc. (These usually contain admixture of inorganic materials.) Landis,[6] in particular, questions the harmfulness of organic dusts *per se.*

(*d*) Sand, granite, marble, slate, glass, ganister, flue dust, flint, chert, quartz, emery, gold, diamond, corundum and carborundum.

(2) *Density* or Specific Gravity.

It seems to be generally agreed that the heavier particles of dust are the least harmful, probably because they settle more quickly. This should be qualified, however, in respect to fine particles which, although of high specific gravity, are capable of being air-borne for some time and distance.

(3) *Shape.*

(*a*) Amorphous. Dusts of this group are probably quite innocuous.

(*b*) Crystalline (angular, acicular, jagged, spined, etc.). These shapes are regarded as harmful largely on the basis of lacerating properties.

(4) *Size.*

Particles larger than ten microns in diameter, though constituting the chief reason for easy visibility, are least harmful since

they are rarely found far within the respiratory passageways. When dust particles are under two microns they appear to be capable of the greatest accumulation in the lungs.

(5) *Infectious Character.*

Dusts may contain spores of disease-producing germs, and the more resisting forms of germs themselves, such as anthrax, streptococcus, diphtheria, tuberculosis. As far back as 1891 Prudden[7] championed the causal relationship between dust in the breathing atmosphere and the spread of tuberculosis, in a tuberculous environment, and his views appear to be receiving renewed emphasis today. The worker with an open case of tuberculosis must be kept from infecting a dusty atmosphere.

(6) *Hydroscopy.*

There is no doubt that dry dust, or dust in excessively dry atmospheres, is more irritating, because of its demand for moisture in impingement upon the mucous membranes. Lowered humidity increases the number of particles while at the same time decreasing their size. Some dusts are so hydroscopic apparently as to be caustic or escharotic in action.

(7) *Chemical Composition.*

It is assumed that practically all poisonous dusts are soluble in the mucous secretions. On the other hand the non-poisonous dusts are either soluble or insoluble, the emphasis for hazard being naturally placed then upon the insoluble forms.

(8) *Protein Sensitizers.*

Anaphylactic phenomena follow upon the breathing of some dusts by some individuals. Recent writers lay stress upon this point in connection with certain dusts, particularly pollens but also any dusty protein matters. To these forms of dusts an immunity is frequently established in a few days and maintained thereafter throughout the period of exposure. This is probably the explanation to the immunity obtained in zinc ague—a complex due to the resorption of killed protoplasm. Landis emphasizes this explanation in the various afflictions known as "shoddy fever," "grain fever," "threshers' fever," "mill fever," etc.

(9) *Reduction of Illumination* resulting in eyestrain, distraction and accidents (Albaugh).[8]

The above is believed to be a practical and working classification for industrial dusts. It will be observed that little attempt is made to distinguish the inorganic from the organic dusts. Prac-

tically all authorities are agreed that inorganic dusts constitute the chief hazardous group to which Mavrogordato[9] lays stress on the crystalline character. He found that even siliceous dusts are harmless if amorphous. As stated, it is a disputed point as to whether organic dusts are in themselves harmful, irrespective of the apparently sharp edges and contours of vegetable fiber dust, hair, scales and the like.

Some other factors enter essentially into the question of the harmfulness of any dust: (1) The duration of exposure; (2) the amount of the dust inhaled per each tidal respiration; (3) the respiratory physiology of the individual, particularly as to whether the person is a nose-breather or a mouth-breather, a deep breather or a shallow breather, etc. An important association is the matter of eyesight, near-sighted individuals getting closer to their work. Furthermore, the careless habits of the individual are important in the matter of creating an unnecessary amount of dust or of habitually placing himself in its thickest clouds. Under this head, idiosyncrasies must also be recognized, some persons seem peculiarly susceptible to respiratory damages, some to skin or scalp afflictions, etc. It is a matter of common observation that among those exposed to the most harmful types of dust are to be found certain individuals who are singularly little affected. After all it would appear that perhaps correct personal hygiene is as big a factor in the question of immunity as any other single item, and, particularly if we include a normal anatomical state of being, that is, a normal nasal construction and a normal bronchial tree. (4) Season and climate, the general rule being that for the skin, at least, the warmer the season the greater the irritant effects. Perhaps an increase in the amount and, particularly, in the acidity of the perspiration is a factor.

Statistics. "These are the bold, relentless records of death," wrote Prudden nearly thirty years ago. Nowhere do statisticians find that the inhalation of dust of any type is virtuous. The earthy dusts, such as clay, loam, lime, chalk, cement and coal, appear the least harmful, yet for cement workers, for instance, Kober[10] points out that diseases of the respiratory organs decreased from 9.3 per cent. to 3.3 per cent. after installing dust prevention apparatus in certain German cement works. In a like manner many statistics have been compiled showing the decrease

in the mortality rates following a decrease in the amount of dust exposure.

The tuberculosis death rates in workers in organic dusts, whether such dusts are in themselves harmful or not, are about the same (5.64 per thousand) as those who work in metallic dusts (5.84 per thousand), while both are excessive as compared to the normal tuberculosis death rate (2.98 per thousand) according to Sommerfeld. Lanza[11] estimates that thirty per cent. of the Joplin zinc miners have "consumption," which is not necessarily tuberculous, but for practical purposes both are the same. The reputation which soft-coal miners have had of being practically immune to tuberculosis certainly is not in accord with the evidence which my own investigations developed in a field study of coal miners in Ohio and Illinois in 1918. Several circumstances favored rather a high degree of accuracy in dealing with these coal miners' statistics. All of the coal miners, approximately 50,000 in Ohio and 90,000 in Illinois, are unionized and, in Illinois, a state-wide death insurance scheme, inaugurated in 1908, resulted in a careful inquiry by the union into the cause of each miner's death. The actual recorded deaths of 5,428 miners showed a rate of 99.4 per 100,000 employed, for tuberculosis, in spite of a violence rate of 398.2. They also showed a percentage rate of 14.6 as against 16.6 for occupied males in the registration area (Census, 1909) when deaths due to violence (36.8 per cent. among miners) and (10.6 per cent. for occupied males) were excluded from both sets of figures.

Miller and Smyth[12] have estimated that a man may inhale from 5 to 106 grams of dust per year into his lungs depending upon its character (pottery dust, flint, steel, carpet or cement dust) and that at this rate a pound of cement dust, for instance, could reach the lungs in from five to ten years.

Infants' lungs contain no silica. Hence probably all of the silica found in lung tissues comes from the exterior. The same holds true of carbon as it darkens solutions resulting from antiformin digestion of lung tissues. McCrae[13] found that the native adult Zulu had 0.73 per cent of silica in dry lung tissue, whereas a worker exposed to the rock dust of the mines of South Africa accumulated as much as 4.57 per cent. Hirsch[14] found from 0.24 per cent. to 3.40 per cent. of carbon by dry weight in the lungs of Chicago dwellers.

Winslow[15] believes that he has discovered the greatest amount of dust yet reported, in the abrasive manufacturing industry, where test showed from 15 to 222 million one-fourth standard particles per cubic foot. These figures exceed the estimates of Lanza for the dusts of the Joplin mines. It is probable, however, that the flint mills, located in some pottery centers would show as high dust counts as any.

Common Sources of Harmful Dusts. The common sources of harmful dusts in industry may be summarized as follows:

(1) Dry sweeping, dusting and cleaning methods.

(2) Dirt, pulverized, brought in on materials used.

(3) Dirt floors, or dust kicked up from dirty floors.

(4) Street dirt and smoke wafted in through windows.

(5) Personal carelessness in handling dusts or performing dusty operations.

(6) Dust from the drying out of pulverized wet materials.

(7) The manufacture or mining of dusty products or substances.

(8) Cleansing and finishing operations, including polishing, grinding, and sand-blasting.

(9) False sense of security when dusts cannot be easily seen or where supposedly protective devices do not protect (Winslow et al.[15]).

Body Defenses Against Dust. (1) The narrows of the air passages (nose, pharynx, glottis, bronchi, etc.). Lehmann[16] found that from thirty-five to forty-two per cent. of fine dust, like white lead, reached the lungs in nose breathing, and as much as eighty per cent. in mouth breathing.

Rivers[17] finds that the horse in coal and ganister mines has no pneumokoniosis, which he considers is due to exclusive nasal breathing. These horses also never have tuberculosis, yet the horse is very susceptible to tuberculous lung invasion, experimentally. He notes also that many human cases of pneumokoniosis and miners' phthisis are frequently associated with wide atrophic nose conditions (useless as a filter).

(2) Impingement in mucus, by which dust is removed in spitting, coughing, sneezing, etc., the whole greatly assisted by the action of the ciliated epithelium.

(3) The toughness or resistance of the mucous and submucous tissues.

(4) The activity of phagocytes composed of leucocytes, endothelial cells, alveolar cells and plasma cells.

(5) Pigmentations. Even colorless dusts become pigmented in the lung tissues and perhaps this pigmentation is a defensive mechanism, as pigmented dusts are more readily eliminated (Mavrogordato).

(6) The lymph spaces with their valvular arrangements and filtering lymphnodes, draining eventually through the bronchial walls and discharging the particles loose into the bronchial secretions to be expectorated.

(7) Antibodies for certain germs. For the *Bacillus tuberculosis* there appears to be a positive reaction stimulating cell growth and tending to encapsulation. Under this heading, also, the antibodies bringing about immunity toward foreign proteins to which some persons seem especially susceptible.

(8) Tissue cell proliferations, fibrosis (Beattie[18]) and perhaps calcification, including fixation of the diaphragm and adherent pleurisy in advanced cases (Landis).

(9) Shortness of breath, because the shallower breathing, brought about as the result of dust pathology, limits the respiratory excursion.

Dust Accumulation. Thompson[19] emphasizes the point that "colds" are often only the reactions brought about by breathing dust.

A most important advance in dust pathology of the lungs has been made by Mavrogordato who points out that accumulation of dust in the lung tissues is the main point after all, and not the amount of dust in the breathing atmosphere, nor, indeed, the amount inhaled. Some dusts are eliminated much more readily and completely than others, hence produce less damage in the long run. In general, dusts producing an immediate catarrhal reaction (coal, soot and shale) are well eliminated, whereas, those, the inhalation of which produces little initial reaction, tend to get in farther, go deeper, or in other words to accumulate and bring about the deeper seated tissue changes. However, the rate of dust invasion should be kept below the rate of elimination. Hence the advisability of limiting all dust clouds in the breathing atmosphere.

Mixed dusts are less harmful than pure metallic or crystalline dusts, and the admixture of organic dusts to the same appears to be beneficial in helping elimination.

The amount of dust accumulation in the lungs seems controllable by keeping the rates of invasion below the rates of elimination and, with these things known or ascertainable, it begins to appear as though a scientific basis is near at hand for estimating the maximum amounts of dusts permissible in the breathing atmosphere, and the proper modifications or admixtures of otherwise uncontrollable dusts that will render them comparatively harmless.

The following is adapted from Hoffman's classification of the character of dust in various trades:*

Group 1. Exposure to *metallic dust.*
   1. Grinders.
   2. Polishers.
   3. Tool and Instrument makers.
   4. Jewelers.
   5. Gold leaf manufacturers.
   6. Brass workers.
   7. Printers.
   8. Compositors.
   9. Pressmen.
  10. Engravers.

Group 2. Exposure to *mineral dust.*
  11. Stone workers.
  12. Marble workers.
  13. Glass blowers.
  14. Glass cutters.
  15. Diamond cutters.
  16. Potters.
  17. Cement workers.
  18. Plasterers.
  19. Paper hangers.
  20. Molders.
  21. Core makers.
  22. Lithographers.

Group 3. Exposure to *vegetable fiber dust.*
  23. Cotton ginning.

Group 3. (*Continued.*)
  24. Cotton textile manufacturers.
  25. Spinners.
  26. Weavers.
  27. Hosiery and knitting mills.
  28. Lace making.
  29. Flax and linen manufacture.
  30. Hemp and cordage manufacture.
  31. Manufacture of jute and jute goods.
  32. Paper manufacturers.
  33. Cabinet makers.
  34. Wood turners and carvers.

Group 4. Exposure to *animal and mixed fiber dust.*
  35. Furriers and taxidermists.
  36. Hatters.
  37. Silk manufacturers.
  38. Woolen and worsted manufacture.
  39. Carpet and rug manufacture.
  40. Shoddy manufacture.
  41. Rag industry.
  42. Upholsterers and hair-mattress makers.

Clinical Effects of Dust. Dust may be inhaled, or affect the skin, the eyes and the ear canals. The daily subjection to dust, for more than brief intervals at a time, is always damaging. The

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* See especially: "Mortality From Respiratory Diseases in Dusty Trades" (Inorganic Dusts) Bull. 231, 1918, U. S. Bur. of Labor Statistics, pp. 40-42.

skin and the eyes may become physiologically inured to it, but not so with the internal organs. The least harmful dusts are those arising from the natural earth itself, such as the farmer is subjected to, although there are many exceptions to this in the case of alkali, sandy, or stony earths, etc. White flour and starch appear to be practically harmless to the normal person, soapstone dust and talc may be placed next in order, but a tuberculously-inclined person subjected to these, if they do no more than irritate the nose and throat and promote coughing, is almost certain to see an increment in his disease. Dusts in general produce a chronic catarrh of the respiratory and digestive organs. This leads to a fibrosis (hence a premature aging). These catarrhs and fibroses result in a lowered resistance of the damaged parts, and invite secondary diseases, which are usually the cause of death.

All diseases of the lungs, due to dust, are called *pneumono-koniosis* (lung-dust-disease); iron dust produces a condition called *siderosis;* sand, flint and stone, *chalicosis* and *silicosis;* coal dust, *anthracosis;* cotton-fibre dust, *byssinosis;* clay dust *aluminosis;* tobacco dust, *tabaccosis;* etc. Fibrous tissue is formed around these particles in the lungs, destroying the function of respiration in such parts, and resulting, in the end, in phthisis, which is usually complicated by the presence of the *Bacillus tuberculosis.* Two-thirds of a pint of coal dust has been found in the lungs of a former coal miner. One-third of the weight of the lungs of a rock-driller has been found to consist of rock dust. Probably the most harmful dusts of all, with the exception of poisonous dusts, are those in group (*d*) (see p. 96), which are composed of exceedingly hard and usually crystalline, sharp particles.

VENTILATION.

While ventilation is defined as the replacement of foul air with fresh (outdoor) air, for practical purposes the healthful character of the *general atmospheric condition* of the work room or work place is what is meant. Analysis of an atmospheric condition comprises four headings with subdivisions as follows:

Physical Conditions. These are considered the most important of the elements making up good ventilation since they are the most variable, the most difficult to control, and especially affect one of the body's most delicate mechanisms—the heart-reg-

ulatory system. The physical factors are easily determinable by precision methods and have been "standardized," so to speak, for different classes of workers, the classification based principally upon the sedentary, semi-active, or active type of the work itself.

(a) The *temperature* should range from 68° F. downward and be just cool enough to be slightly stimulating but not so cool (for the given work-activity) to be irritating, distracting, or depressing.

Those who have traveled considerably note that the "proper" temperature for comfort is much a matter of custom and usage and, perhaps, of education, in various countries. Prof. Allen states that while traveling in Mexico, where the air was excessively dry, he found that even in a temperature in the hot sun at 140° F., he suffered no inconvenience, in fact hardly perspired, also sunstroke was practically unknown. On the other hand, traveling in Cuba with a temperature scarcely above normal but the humidity high, the effects were noticeably oppressive. In America the customary indoor temperature is invariably set high as compared with almost all other countries. The tendency, however, is to have the indoor temperature habituation higher and higher as one goes further from the tropics. In England, a comfortable temperature is that of 60° F., which, accompanied with the usual good percentage of humidity, proves quite comfortable. Elsworth Huntington,* in his work on *"Civilization and Climate,"* calls attention to the point that, if the fortieth parallel of north latitude be traced around the globe, it will be found that practically all

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*"Elsworth Huntington, after a careful study of meteorology in reference to man, concludes that civilization in the broader sense of the term is largely dependent on man's being subjected to considerable variations of temperature in his environment. Whenever white men, in spite of their natural initiative and tendency to efficiency, have to live and work in a tropical climate, they degenerate physically, mentally and morally. This, Huntington insists, is due not so much to the high temperature as to the monotony of an unvarying climate and the consequent lack of Nature's most effective stimulation. . .It seems to be a law of organic life that variable temperature is better than uniformity . . The fall and the spring are the best working periods of the year for all kinds of work. A study of storms and their stimulating effect shows that change, especially rather sudden changes, of thermometric and barometric phenomena, are distinct stimulants. On the other hand, when the temperature remains more or less constant from day to day, people work and think more slowly. Every time that a storm passes over a region and is followed by cooler weather, people's efficiency is increased." Editorial, Jour. Amer. Med. Assn., Feb. 26, 1916.

the great centers of human achievement are situated not far away from it. Athens, Constantinople, Naples, Rome, Florence, Paris, Vienna, Berlin, London, New York, Chicago, St. Louis, San Francisco, Tokio and Pekin, as well as Jerusalem, Tyre, Memphis and Babylon—all situated within about 10 degrees of this magic line. *Variation* in temperature represents one of the best tonics provided by Nature. "Lauder Brunton believes that tuberculosis patients will not get better in a climate that does not vary from 20 to 30 degrees every day."

The *effects* of increased temperature upon the human body was pointed out by Hermann in 1883, when he noted an increase in body temperature more or less in keeping with an increase in the surrounding temperature of the air. Winslow[20] sums up the effects of temperature upon the human body about as follows: An increase of temperature above 68° F. (relatively humidity 50 per cent.) raises the body temperature as follows:

Temperature,	68° F.	Body Temperature,	98.6° F.
"	75° F.	" "	98 9° F.
"	86° F.	" "	99 1° F.

It increases pulse rate; decreases diastolic blood-pressure; especially decreases the cardiovasomotor tone (the Crampton value); decreases the will power to work, although it may not decrease the ability to work either mentally or physically, especially for a short time; it increases the tendency to take life easy; invariably decreases the amount of output such that there may be a difference of as high as thirty-seven per cent. between work done at 86° F. and that done at 68° F.; and, finally, an increase in indoor temperature is much more noticeable than the same increase in outdoor temperature, due to the difference in air motion and perhaps humidity.

Huntington suggests a pause in the medical practice of sending invalids to a mild climate during the winter unless they are of such delicate constitution, or so run down in health, that they cannot stand the cold. The same thing would seem to be true as regards neurasthenics and semi-invalids. The bracing tonic qualities of a northern winter in a dry climate under proper safeguards will probably do them more good, though at times they will be less comfortable than they would be in a warm southern atmosphere. Winslow believes that cold air baths may be equally

as beneficial as cold water baths. Huntington[21] states that physical work reaches a maximum at 59° F. for men and 60° F. for girls. Above these temperatures, the curves for physical work begin to fall. Consequently the curves show seasonal fluctuations.

"The plan by which warmed air is pumped into the shop—commonly known as the 'plenum system'—tends to create an atmosphere of a highly relaxing and depressing character. It affords a striking example of how chemically pure air may, by its uniformity and monotony, constitute an atmosphere in which good work is hardly possible. The means of ventilation should be kept separate from that of heating and the 'plenum system' should only be used to pump in cool air in summer." The table herewith shows what relation should exist between the simple factors of temperature and humidity to provide for the proper comfort zone.

ZONE OF COMFORT TABLE.

For temperature of	Relative humidity should be Per cent.
60° F.	66 to 74
66° F.	50 to 54
68° F.	40 to 48
70° F.	34 to 40
72° F.	30 to 34

It is coming to be realized that the chief effect of the "open air treatment" in the control of tuberculosis is the cooling of the body surface through exposure to a greater motion of the air, which thereby stimulates by lowering the temperature immediately about the skin, rather than anything inherent in the freshness of air. Consequently, it has been quite well established that proper treatment for tuberculosis can be carried on at home, that is, in any state in the Union, as well as in certain states whose reputation has been established and whose facilities, particularly for those without proper funds, are much overtaxed in attempting to accommodate those unfortunates who resort to these states when they could be much more successfully treated at home.

(b) The *air movement* in the stiller atmospheres required for sedentary workers should be estimated by practical visible means such as smoke whorls (josh-sticks, a cigar, ammonium chloride vapor, etc.) and should never be less than one-half foot per second.

The movement should also be rather pulsating, always changing in direction and never "drafty," *i.e., playing* continuously from one direction on a part of the exposed body, and particularly if the "draft" is more than 10° F. cooler than the room atmosphere.

The question of the velocity of the air to be desired depends upon the activities of the individual. The person at rest wants no more than a "just perceptible breath" stirring in his vicinity. This amounts to about two feet per second, or a matter of one and one-half miles per hour. Persons engaged in active work require a velocity of several times this much—in fact, as much as is naturally supplied in outdoor situations (modified by the amount of clothing worn). Also the warmer the weather, or the higher the temperature, or the greater the humidity content, the greater should be the velocity. The reverse also practically holds true, as cold, damp surroundings are rendered worse to tolerate through any increased velocity of the air currents. Carpenter[22] gives the following table arranged from Loomis' Meteorology:

RELATION BETWEEN VELOCITY AND FORCE OF AIR
(AS GAUGED BY THE SENSATION).

Sensation	Velocity		Pressure
	Miles per hour	Ft. per second	Lbs. pr. sq. ft
Just perceptible	2.0	1.92	0.02
Gently pleasant	4.0	5.85	0.08
Pleasantly brisk	12.5	18.3	0.75
Very brisk	25.0	36.6	3.0
High wind	35.0	51.5	6.0
Very high wind	45.0	66.0	10.0
Strong gale	60.0	88.0	18.0
Violent gale	70.0	105.0	24.0
Hurricane	80.0	117.0	31.0
Most violent hurricane	100.0	146.0	49.0

(c) An optimum *humidity* is recognized, that lying between forty and seventy per cent. of aërial water saturation. This element is usually greatly at variance from the provisions found in nature, being occasionally excessively high (as on humid days of the spring and summer, or by artificial admixture of steam or water vapor with the air), but more often excessively low (the usual condition indoors in the winter season).

The effects of a *dry atmosphere* are at first stimulating then cooling, with an increased rate of heat loss from the body; in addition there is often a symptom-complex of "aridity shock" or irritation to the respiratory mucous membranes, the physical basis for a "cold."

(d) A *replacement,* or exchange of air in the work space is essential so as to insure against undue contamination and pollution of air used over and over again. A good standard is usually placed at not less than six times per hour, and preferably much more for busy, active work. The results of the experiments made by the New York State Commission on Ventilation on the effects of the recirculation of air are quoted verbatim:[23]

"The conclusion was reached that there seemed to be no appreciable difference between washed recirculated air and outdoor air similarly treated so far as bodily comfort is concerned. Naturally the proportion of carbon dioxide is greater when using the recirculated air, but no significance is attached to this fact. Mr. Whipple concludes that recirculation provided a plentiful supply of air with no apparent sacrifice of wholesome properties, and that it is a safer source of supply than outside unwashed air. The carbon dioxide averaged 12.5 parts per 10,000 in the Jackson School and 9.1 parts per 10,000 in the Adams School. Dust counts showed 105,000 particles per cubic foot of air in the Jackson School and 225,000 in the Adams School. As a result of these experiments, covering a period of four months, the conclusion is offered that it is impossible to demonstrate physical or mental deterioration due to the use of recirculated air. Neither is it possible to ascribe any discomfort on the part of the pupils or teacher to this recirculated air. It is manifest that a large amount of heat is saved, and this certainly warrants the most careful study of the problem of recirculation. Should it prove in every way satisfactory a great step in advance will have been made in the field of mechanical ventilation. But it may not be recommended as yet."

Kimball's figures show that in the plant at Springfield the cost for recirculated air is 52 cents per hour, for direct ventilation of the same thoroughness 107 cents per hour.[24] *

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* The extent to which washed air can be recirculated depends, of course, upon the amount of dust in the air. While the air washer is in operation, I do not believe that any of the dirt held in suspension in the water will be transferred to the air (E. V. Hill).

(e) *A working space* not below a certain minimum in area (20 square feet) or in cubic content (200 cubic feet) should be provided for each adult worker. This feature prevents undue crowding of workers ("droplet" infection).

(f) *Variableness* should obtain in each of the physical factors listed, particularly in temperature, air movement and moisture content, somewhat in imitation of nature, *i.e.,* when natural conditions (could they be had) would permit the given type of work to be performed comfortably and without risk to health.

(g) The *dust content* of the atmosphere should be as near that which the natural dust content for the place would be were no industry located there. Attempts to state the maximum number of dust particles permissible per cubic centimeter or cubic foot have been essayed, but, as yet, more experience is needed before agreeing upon any standard for this.

Chemical Conditions of the Air. This question was formerly considered the most important phase of ventilation but is now relegated to a minor position since it has been found that, except in almost hermetically sealed spaces, the *oxygen* and *carbon dioxide* and other natural (*gaseous*) constituents of the air maintain their normal percentage relationships excellently well of themselves, and hence need little time spent in checking them up. Also the body's ready adjustment to considerable variations in the two main gases, is now better appreciated. The employment of this argument, however, as warranting the sole use, for economic reasons, of recirculated (even though "washed" air) instead of fresh air is not tenable, for we do not know the effects in the long run of such a practice.

The experimental evidence covers only short exposures and we should not overlook the point that it is quite contrary to anything natural. The occurrence of industrial gases and chemical impurities of any type in the breathing atmosphere is yet quite another question, and, except that for some of them a physiological maximum to toleration has been computed at least for short exposures all should be considered obnoxious and in the end, disease inviting. In the same category, odors of nauseating type, and perhaps all *odors,* should be looked upon askance.

Gases, vapors and fumes irritate the respiratory passages and eyes and may cause poison by absorption. The most important (according to Thompson[25]) are: Illuminating gas (oil gas),

gases from coke and coal (coal gas), carbon dioxide (brewers' vats, bakers' ovens, aërated water); chromic acid; mineral acids: sulphuric, hydrochloric, nitric, etc. (acid factory workers, engravers, etchers and lithographers); mercury cyanide; heated lead; ammonia, ammonium carbonate, ammonium chloride; tar and creosote (distillers); asphalt and petroleum products (naphtha, benzine, gasoline—used in dry cleaning and otherwise); smoke (firemen, varnish makers, and varnishers); arsenuretted hydrogen (copper refiners); ferrosilicon; amyl alcohol, wood alcohol; dinitrobenzol, nitroglycerine, cordite; carbon disulphid; chlorine, chlorid of lime, carbonyl chloride; phosgene (dyeing industry); formaldehyde; hydrofluoric acid; hydrocyanic acid; ammonium, sodium and potassium cyanides; pyridine; sulphur and sulphuretted hydrogen; aniline; dinitrobenzene and dinitrotoluene vapors.

Biological factors may endanger a working atmosphere. These are in the nature of pathogenic bacteria, protozoa, insects, pollen and similar animal and plant complexes. If there is any place where air-borne disease, particularly of bacterial nature, has an opportunity to portray its possibilities it is in a closely confined, crowded work room.

Finally, the **physiological impressions** of comfort or discomfort in the given atmosphere should be carefully considered. Usually two estimates are necessary, one upon entering the given atmospheric space, which E. V. Hill calls the *primary sense impression* and the other, after sometime spent in the given atmosphere. The harmful impressions are expressed by such terms as "stuffiness," "closeness," "too warm," "drafty," "hazy," "swimming," "irritating," "sleepy," etc. If workers could be trained to whet the delicacy of sense impressions and be guided more or less accordingly, these physiological methods could be relied upon for guidance. They would also be easier of application, more natural, and filled with more meaning than determinations made by precision instruments and the like.

Ventilation Effects. There is nothing to be gained by rehashing the "bad ventilation" diseases at this place and the reader is referred to the usual textbooks of medicine and especially of hygiene therefor. The evidence of causal relationship is overwhelming, although rarely specifically proven, and is based on empirical, statistical, clinical and traditional observations, with

strong experimental and laboratory support in some features. Furthermore we have but to reflect upon the effects of an unnatural atmospheric environment as compared to a natural one to suspect the consequences so evident about us. The most conservative must at least admit the production of a condition of lowered resistance as the result of life in an unnatural atmosphere.

Paul, Erclentz, Haldane, and Leonard Hill abroad, and the New York Commission on Ventilation showed the effects of even moderate elevation of the temperature and humidity to be depression, headache, dizziness, and a tendency to nausea. Those with heart trouble are most affected. Those with emphysema slightly. The inclination for physical work is greatly reduced under such conditions and for mental work only slightly less so. "The most important effects of even slightly elevated room temperature, such as 75° F., are sufficiently clear and important to warrant careful precautions against overheating."

HUMIDITY.

Dr. Graham Rogers was among the first in the United States to investigate the humidity question over a considerable number of different kinds of industries. He gives a clean cut statement of the humidity concept in the Annual Report to the New York State Department of Factory Inspection for the year 1909:

"Air always contains a certain amount of water in form of vapor; this moisture in the atmosphere is referred to as absolute humidity, or as relative humidity. *Absolute humidity* is the amount of water vapor expressed in certain number of grains per cubic foot of air. *Relative humidity* is expressed in the form of a percentage. In speaking of humidity, the relative humidity is usually meant, and depends chiefly upon the temperature of the air. If we make moist air colder, we increase its relative humidity without increasing its absolute humidity."

While the question of humidity is an aërial one, in industry it is often associated with water sprays, splashings, steam, water under foot and other forms of wet work. Damp places, therefore, are not always a mere matter of excessive water vapor in the air. Where absolute humidity from any cause is maintained at a higher point than 70° F. "wet bulb," change in temperature either up or down, from the customary normal (68° F. for sed-

entary work) is very apt to endanger health. Winslow states that "we have thus the somewhat paradoxical situation that excessive moisture increases the bad effects of either heat or cold."

Natural humidity varies greatly in the same locality and the averages for different localities also differ greatly. Over desert areas humidity is stated to drop as low as 30 per cent. of saturation, *i.e.*, 30 per cent. relative humidity. In the usual weather conditions of temperate zones it varies from about 55 per cent. to 80 per cent. on fair days and runs up to 100 per cent. during rains, fogs, snow storms, and, on the ground surface, in the condensation called "dew." It is to be emphasized that natural humidity in the inhabited portions tends to average between 60 per cent. and 70 per cent. Winter heating, as carried out by the usual methods, brings about a condition of relative humidity which is often exceedingly low, *i.e.*, under 30 per cent.

(*a*) The *effects of too much humidity* are so intimately connected with the range of temperature that it is quite impossible to separate the two in determining what is comfortable and safe. The evidence submitted by a number of authorities is now quite conclusive. Fluegge, in Germany, and Haldane, in England, showed that when *temperature rises* to 80° F. with moderate humidity, depression, headache, and dizziness come on. As humidity increases, the conditions become worse. When the air reaches 78° F. temperature and 100 per cent. humidity, Haldane found that workmen begin to get fever and those who work in warm, moist air suffer from heat more than any other group. Finally, heat stroke may appear. They are also more liable to rheumatism, asthma, colds, and the various forms of infections. It is the "sensible" temperature, or that indicated by the wet-bulb thermometer which the body feels, and the actual or dry-bulb temperature and the relative humidity are of minor importance under ordinary air conditions. Frederick S. Lee[26] summarizes as follows:

"When an individual is subjected to an atmosphere that is charged with an excessively high temperature and high humidity, his bodily temperature is raised, his working power becomes limited and there is an early onset of fatigue. In addition to the normal fatigue substances there are present other substances, products, of an abnormal metabolism, perhaps of increased proteid disintegration, which likewise act as fatigue substances. Both

the normal and the pathological fatigue substances act toxically
to diminish the activity of the tissues, and such fatiguing action
is rendered greater by reason of the abnormally high internal
temperature that is present." I quote directly from the con-
clusions drawn by Leonard Hill, *et al.*[27]

"In the warm, moist atmosphere of a crowded place, the in-
fection from spray, sneezed, coughed or spoken out is great. On
passing from such an atmosphere out into the cold, moist, ex-
ternal air, the respiratory mucous membrane is suddenly chilled,
the blood vessels are constricted, and the defensive mechanism of
cilia and leucocytes is checked. Hence the prevalence of colds in
the winter."

In brief, it may be stated that when the temperature rises
above 70° F. and the wet-bulb reads as high as 70° F., the
border line of comfort is reached and if both mount above this,
physiologic strain in the matter of dispersing the normal heat of
the body takes place. In this condition people begin to remove
extra clothes and eventually to do less and less active work.*

An instance of the effects of high room temperature with
artificially produced humidity came to the author's attention in
the spring of 1916 when one of the large plants in Dayton, Ohio,
was visited by a peculiar affliction among the female workers in
certain departments which first was deemed to be due to ptomaine
poisoning, then purposeful poisoning by persons or agents in-
terested in obstructing the work. The employes were all girls and
women and there was undoubtedly a good deal of hysteria about
the total manifestations. One or two workers would become
dizzy and drop over in a faint. Upwards of a hundred or more
working in the room would become affected in short order. Pres-
ently, the whole room was in a confusion with girls and women
dropping all round. Associated with this circumstance, which
occurred on two or three different occasions in the space of a
couple of weeks, were diarrhea, sickness to the stomach and ab-
dominal pains—symptoms, let it be observed, not at all dissociated
from the phenomena of thermic fever and heat prostrations. Two

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* "There is a percentage of humidity which is most comfortable for a
given temperature. This humidity may be determined within the short
range of indoor temperatures from the formula $R = 316 - 4\ T$, in which
T is the temperature of the room and R the corresponding relative
humidity." Hill, E. V.: *Ventilation Requirements and Test Methods,* Jour.
of the Western Soc. of Engs., Feb., 1916.

inspectors of the Russian government who were present stated that the same phenomena occasionally occurred in similar works at home. An investigation by the Division of Industrial Hygiene of the State Board of Health was made. Practically all the work was done under air-conditioned arrangements by which a relatively high humidity was maintained—in fact, was called for in the company's contract in order to insure standardization of the munitions produced, which were of a high grade of precision type. The company had kept careful records obtained by self-recording instruments of the daily temperature and humidity conditions. A study of these showed that the temperature and humidity were allowed to become excessively high upon occasions, the former up to 78° F. and the latter to 75 per cent. The air conditioning apparatus also furnished some circulation of the air but at a velocity undoubtedly too low for the other conditions present. It appeared that the contract only prescribed a relative humidity of 60 per cent. Inasmuch as there were several thousand employes working under these conditions the solution of the mysterious circumstance was very essential. The suggestion was made that relative humidity be not allowed to exceed 60 per cent. nor the temperature 70° F. This was conformed to. No more disturbances of the above nature occurred throughout the excessively hot summer which followed and we were informed some six months thereafter that there had been an immediate daily increase in general production amounting to ten per cent.!

(b) *High relative humidity combined with low temperature, i.e.,* a cold, damp combination, or work carried on in a cold, damp place, is likewise conducive to health impairment, especially depending upon a third factor—the amount of exercise. In fact, this can be seen from the statistics compiled by Bertillon and is especially emphasized in one of his conclusions concerning weather-exposed workers who do not obtain the proper amount of exercise. Active work, on the other hand, may entirely counteract any detrimental influences since (the temperature of the body being much higher than that of the surrounding atmosphere) there is no difficulty in dispersing heat generated in the body; at the same time the vasomotor regulation of the body supply to the skin is kept in tone by the exercise indulged in so that undue heat loss, local or general, is prevented.

(c) The effects of *sudden changes* from one condition to the other, as in going in and out of doors, are stimulating or relaxing, but both conditions are very likely to be overdone, especially in the case of the nasal apparatus. Hubbard[28] speaks of the "humidity shock" to the mucous membranes of the nose and upper air passages. In going from a relatively dry atmosphere to one of high humidity plus high temperature, there is usually a rapid loss of tone in the vasomotor system, resulting in relaxation in the skin and muscles and a rapid accumulation of blood therein. The nasal mucous membrane becomes swollen and red and there takes place a marked increase in secretions while at the same time the size of the air passages is much reduced in the nose— in fact, perhaps actually blocked. Beads of perspiration stand out upon the skin and, failing to evaporate, fail to cool the skin. This quickly results in an increase of temperature of the whole body—"thermic fever." Easy fatigue is another phenomenon which appears.

On the other hand sudden changes whereby the person passes from a dry and well-heated interior to the out-of-doors, as upon a cold, damp day, causes a rapid displacement of blood from the skin to the interior with a great tendency to sudden congestion. These are the likely explanation of lameness, stiffness and pain upon use which occur under the names of lumbago, wry neck and muscular rheumatism. Moreover, the vital organs which have only relatively low means of vasomotor defense are often involved in these sudden congestions. The stagnation of the blood in these parts invites ready infection from the presence of the occasional germ which floats in the blood, especially where there is any chronic infection already present (teeth, tonsils, prostate) or where there is any inherent weakness in the parts so flooded. Particularly does this appear to occur when the extremities become chilled. The nasal membranes shrink, become pale, secretions decrease as a rule, and the passageways for air enlarge.

(d) Those whose work necessitates *exposure to water or to rain and inclement weather* make up another class of exposures. These especially should not be required to do inactive work. Occasionally the surrounding temperature can be controlled and made comfortable, but in that case undue relaxation ensues. Recreation periods, at least, should be arranged for. This class of workers should also be provided with rubber boots, rubber gloves,

etc., and protected in every way by mechanical means devised to remove water and steam. ·Where certain other health-hazards such as dirt, dust, heat or fatigue are associated with this general feature of wet or damp work, workers should have full bathing facilities, such as the shower bath, and obviously, such necessities as lockers located in a drying room for the drying out of clothing between work spells.

(c) Effects of *excessive dryness,* or "aridity," are not so palpable as those described above. There is a reported effect in "decreasing the steadiness of the hand, the eye, or the arm, or in causing confusion of mind or distraction," but this is very slight, if any. "Dryness," itself, is a common complaint and usually signifies a very low relative humidity (under 30 per cent.). Dryness promotes rapid heat loss from the skin and therefore cooling effects which may be disastrous. Statistical studies of climatic variations, taking into account dryness, according to Huntington show distinct harmful effects when measured by the death rate. In general, hot dry air is exceedingly cooling, produces a socalled "aridity shock" which in many persons is regarded as the mechanical cause of colds, upon which infection follows. Dry warm air is unnatural and wild animals brought into its influence suffer various "shock" results in the mucous membranes of the respiratory passages, much the same as human beings.

TEMPERATURE.

Temperature, in its ordinary ranges, has been discussed under the head of Ventilation and of Humidity. However, the human being is often subjected to extremes of temperature, both heat and cold. Records show that temperatures have been successfully withstood from — 72° F. to 250° F., a range of 322°. In fact it is probable that the upper figure mentioned has been exceeded without apparent damage to the exposed person. Adaptation to such extremes is possible only when atmospheric conditions of humidity, motion, and perhaps pressure, are correct.

In general, **high temperatures** are successfully withstood when the air is in rapid motion and is dry. We all know that 100° F. is not incompatible with work, both physical and mental, provided the condition of a brisk, dry breeze is attendant. There is evidence to show that adaptation to increase of temperature is pos-

sible through practice. In fact the first consequence of importance appears to be the effects upon the eyes which may fail to retain moisture enough in the conjunctival sacs to prevent drying effects. The heat also, particularly radiant heat, unquestionably tends to the development of posterior cataract. It is commonly believed that negroes and other dark skinned races have a greater tolerance. In medical practice, heat stroke is noted among females only once as compared to fourteen times in males, which, however, is probably more a representation of relative exposure than of any relative immunity. Certain types of persons withstand high temperatures badly : alcoholics, the weak, the senile, those who have overeaten, those who have been "heat struck" before, those suffering from chronic diseases, and the fatigued.

Evaporation of moisture from the body surface by sweating is the chief factor in cooling the body, but without a sufficient supply, too much may be removed, leading to one of the dire consequences of heat exposure—asphyxia. The military writer, Lelean, says that, whereas water forms about sixty-six per cent. of the total body weight (a matter of 100 pounds or 10 gallons in a 168 pound man) the loss of one gallon involves danger and one and one-half gallons causes death. Each quart evaporated removes about 600 calories of heat from the body.

The following in brief suggests the situation :

Wet Bulb Readings.	*Bodily Effects.*
72° F.	Discomfort
85° F.	Limit of work
88° F.	Probable heat stroke

In the body itself a mouth temperature of 110° F. is usually fatal although 117.8° F. has been recorded. A temperature of 120° F. is said to bring about rigor.

The different types of *effects* due to heat exposure may be summed up as follows :

(*a*) Heat stroke, thermic fever, sun-stroke or insolation (see textbooks on medicine for symptoms hereof). This condition comes on suddenly and is the result of a combination of elevated temperature, high humidity, and air stagnation anywhere. Direct exposure to the sun is not necessary and, in fact, the onset may be initiated during the night, some hours after the exposure. The condition appears to be an autointoxication. All the secre-

tions including the blood are toxic. The urine is said to contain creatinin, xanthin, uric acid, and other bodies showing deficient oxidation.

(b) Heat cramps: These occur in the sets of muscles most used during a hot day or during exposure to elevated temperatures. They are seen in miners who work at great depths, firemen, stokers, foundrymen, etc. Stomach cramps, so commonly reported in workers in hot places after drinking iced water, are probably different; they also seem to be less consequential.

(c) Sequelæ following heat stroke or exposure to high temperatures: These may be a remittent fever, constipation, spells of vomiting, attacks of suppression of the urine, and also suppression of sweating. There is an increase in susceptibility to infections and systemic diseases. The mental state seems to suffer in the matter of concentration and memory. Insanity follows in some four per cent. of cases.

(d) Effects of prolonged exposures. Here a group of afflictions is associated such as anemia, respiratory diseases, Bright's disease, attacks of lumbago and rheumatism, dyspepsia, intestinal irritability, eruptions of the skin (prickly heat, etc.) ocular afflictions (cataract, chronic conjunctivitis, retinitis and choroiditis) and premature aging. Also, easy fatigue.

(e) Cases of heat exhaustion occur among the weak, alcoholic, diseased and senile. Prognosis is generally worse in these cases, at least a protracted recovery is the rule.

Prophylaxis covering heat exposure disasters consists in the following measures: (1) Selected workers; (2) selected clothing; (3) provision for showers, lockers, and change rooms; (4) short hours; (5) plenty of work space; (6) frequent rest periods (workers before furnaces, etc. should be relieved about every 15 to 20 minutes and allowed twice this length of time for rest); (7) supervised diet which should be moderate in amount and consist especially of vegetables and fruits; (8) supervised prevention of constipation (including laxatives and purges). Industrial avoidance of exposure to high temperatures include the following: (1) Put the air in motion; (2) keep the air dry; (3) minimize the dust; (4) install convection schemes—fans, blowers, ducts, etc.; (5) confine the heat, as by (asbestos) coverings to furnaces, insulating walls, etc.; (6) erect shields to deflect the heat; (7) evaporation schemes—water spraying, etc.; (8) ab-

sorption schemes—circulation of cold water, etc.; (9) increase of the working distance as much as possible, and (10) placing of thermometers in salient positions for frequent observations.

Cold. Cold is experienced as a work hazard under such conditions as the following: High altitudes, ice fields, decompression in caisson work, ice houses, storage warehouses, and, in the winter, cold passageways, basements, isolated toilets, or privies, etc. Some processes have a mixture of heat and cold exposure, such as the older methods of chocolate dipping, in which girls may sit in a warm room before a cooled table-top upon which chocolates are coated, the lowered temperature from which affects the legs and feet.

As stated under Ventilation, a "draft" is an incoming air of less than 10° F. under the general room temperature.

A combination of high humidity and low temperature is hazardous as this permits heat radiation from the body by means of the water vapor present. Low temperature with much air motion is hazardous because the heat is rapidly removed from the body by convection. Cold alternating with heat at frequent intervals is especially hazardous although some adaptation is possible by practice.

The *effects of cold* are: Reduction of skin and mucous membrane temperatures (nose, throat, tonsils), reduced resistance to infections, slowed circulation, deposition of fibrin coagula of minute proportions in the capillaries which may constitute multiple thrombi upon release from the cold, which thrombi may impede the circulation in the lungs, liver, and kidneys (thus laying a theoretical basis for congestions, inflammation, etc.), mental depression, neuritis, Bright's disease, rheumatic fever and frostbite of exposed parts, followed, perhaps, by gangrene (moist or dry). If a part of the body has been generally chilled, as in the case of the feet, and without opportunity for good voluntary activity, a condition of "trench foot" may result.

The prophylaxis and control for exposures to cold are: (1) Loose clothing, including shoes; (2) body activity; (3) nourishing food (stressing carbohydrates and fats); (4) still, dry air, and (5) robust health (that is the weak, aged, and diseased must be precluded).

ILLUMINATION.

Since it is impossible, and often undesirable, to do all work in daylight, it becomes necessary to observe certain standards for interior lighting. Artificial lighting has one set of standards and natural lighting another. (1) As a general proposition, eye-workers require from 5 to 10 *foot-candles* of artificial light for ordinary eye-work.[29] The strength of daylight should be about three times this amount. Finer work requires more foot-candles of light focused upon the working plane. Where contamination of the air occurs, light is going to be obstructed. Diffused daylight and that reflected from the sky is better than sunlight. (2) In *color,* artificial light should simulate diffused skylight as much as possible, the Welsbach mantle or the tungsten electric lamp with "daylight" bulb appearing to come nearest the ideal. (3) *Glare* must be carefully avoided by an intelligent comprehension of the angle of glare, the intensity of the intruding light, etc. How often do we see office and factory workers seated facing the light! The vast amount of importance to be given to accessories, such as shades, reflectors, globes, color of working surfaces, etc., requires the services of a lighting expert, if for no other reason. Many times, proper positions and lighting accessories[30] enable the total expenditure for lighting to be greatly curtailed, and with an increased efficiency. (4) Again, a flickering or *unsteady light* can be just as fatiguing from its effects upon the human eyes as the most laborious work. (5) Absence of sharp *contrasts*[31] between lights and shadows may or may not be desirable. (6) Investigations in schools have shown the great influence of *clean windows*[29, 32] upon the quantity of light, this influence amounting, perhaps, to as much as increasing the foot-candles of light on a desk top from 2 to 10. (7) *Dark colored walls and surroundings* may absorb as much as seventy per cent. of the available light, whereas light colors absorb but little and reflect much. Windows placed high give better light, because of increased exposure to sky surfaces. Window shades, therefore, should be attached at the bottom and pulled upward. (8) The *ratio* of window area to floor area should be about 1 to 4 for general interior lighting. (9) In buildings with extensive floor space this ratio will often be found greatly curtailed while machinery, shelving and benches often greatly limit or *obstruct* the amount of light present on

working planes. (10) Occasionally, we find workers exposed to intensely *brilliant* lights without proper protection to the eyes and even to the skin. (11) When all of these features indeed, are corrected, *defective eyesight* is so common that ocular examination of workers is imperative. The great importance of proper illumination and good vision is shown in regard to the following wasteful results: Accidents, eye-strain with its manifold accompanying health disasters, defective execution, defective product and decreased output.

The following is taken from the "Code of Lighting for Factories, Mills and other Work Places," Council of National Defense (divisional committee on lighting, etc.).[33]

Rule 1. General requirements. Working or traversed spaces in buildings or grounds shall be supplied during the time of use with artificial light in accordance with the following rules when natural light is less than the intensities specified in Rule 2.

Rule 2. Intensity required. The desirable illumination to be provided and the minimum to be maintained are given in the following table:

	FOOT-CANDLES* AT THE WORK	
	Ordinary practice	Minimum
(a) Roadways and yard thoroughfare	0.05 — 0.25	0.02
(b) Storage spaces	0.50 — 1.00	0.25
(c) Stairways, passageways, aisles	0.75 — 2.00	0.25
(d) Rough manufacturing, such as rough machining, rough assembling, rough bench work	2.00 — 4.00	1.26
(e) Rough manufacturing, involving closer discrimination of detail	3.00 — 6.00	2.00
(f) Fine manufacturing, such as fine lathe work, pattern and tool making, light colored textiles	4.00 — 8.00	3.00
(g) Special cases of fine work, such as watchmaking, engraving, drafting, dark colored textiles	10.00 — 15.00	5.00
(h) Office work such as accounting, typewriting, etc.	4.00 — 5.00	3.00

* The foot-candle, the common unit of illumination, is the lighting effect produced upon an object by a standard candle at a distance of 1 foot; at 2 feet the effect would be not one-half foot-candle, but one-fourth foot-candle, etc. A lamp which would give off 16 candlepower uniformly in all directions would produce a uniform illumination of 1 foot-candle at a distance of 4 feet in any direction.

NOTE: Measurements of illumination are to be made at the work with a properly standarized portable photometer.

Rule 3. Shading of lamps. Lamps shall be suitably shaded to minimize glare.

NOTE. Glare, either from lamps or from unduly bright reflecting surfaces, produces eye-strain and increases accident hazard.

Rule 4. Distribution of light on work. Lamps shall be so installed in regard to height, spacing, reflectors, or other accessories as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensity.

The *bodily effects* of various types of illumination are to be summarized thus:

1. Upon the morâle: A bright illumination is elating particularly if the air is pure and visibly dust-free.

2. Upon the mental state: A bright illumination is stimulating (theatres), while a dull illumination is calming (churches).

3. Nyctalopia or night blindness: The result of exposure to certain colored or iridescent lights over a period of time (zinc smelters, etc.).

4. "Day-blindness"—inability to see accurately on first entering a dark space (mines, tunnels, etc.).

5. Eye-strain: Evinced by headache, unaccountable fatigue, dyspepsia, blepharitis, conjunctivis, styes, and perhaps retinitis—leading to work imperfections, decreased output and accidents. Alleged also to affect epileptics adversely.

6. Cataract: (See above under High Temperature). Scientific opinion favors heat rather than illumination as the basis of industrial cataract (glassblowers, puddlers, etc.).

7. Nystagmus: According to Shufflebottom, the most common occupational disease in the British Isles, occurs among coal miners. The consensus of opinion is that it is due to poor illumination which in turn is due to the necessary use of safety lamps in the gaseous mines, which lamps give poor light. The generally non-gaseous character of American coal mines (*i.e.,* explosive gases) permits the use of the brilliant carbide, naked-flame lamp, and probably accounts for the rarity of the disease here.

8. Electrica ophthalmia; also called "flashed eyes:" the symptom complex of acute ophthalmitis following the witnessing of brilliant light flashes.

9. Skin effects: Freckles, sun-burn, light "burns" from welding lights—a broadly extending dermatitis—and epithelioma due to x-ray or actinic ray effects.

10. Sterility: An alleged effect of x-rays.

11. Constitutional dyscrasias: Anemia (?) ; increased incidence or progress of tuberculosis; lowered resistance to diseases in general.

POISONS.

Were as much attention given to the effects upon health by poisons as is given to the methods and purposes for which they are used, poisons would be very little troublesome as health-hazards. As a rule, poisons do not need to be dispensed with in industry simply because they are health-hazards, but àll poisons should be absolutely removed from the possibility of damaging the health of the worker. Instead of this firm attitude, most employers, and, indeed, employes, prefer to withstand or tolerate as much as possible of the poisonous substances. Habituation to poisons as before explained should be looked upon as entirely untenable since, with the exception of biologic poisons, no immunity is acquired to any poison. Systematic poisoning is undoubtedly a question of the concentration[34] of the noxious substances in the blood stream which, in turn, depends upon the resistance to absorption of the poison into the tissues and the capability of the eliminative organs to get rid of the same. The rule should be that persons exposed to poison, or the handling of a suspicious unknown substance, should be selected first by physical examinations and thereafter carefully supervised and all minor health complaints investigated. Especially should personal hygiene be dwelt upon. Personal peculiarities in regard to poisons are largely matters of personal hygiene, while the degree of physiological perfection or imperfection supplies the rest of the explanation. It is the employer's responsibility to see that his workers are properly instructed in regard to the use of poisons.[35] The toleration limits of many of the common poisons have been experimentally determined.[36] As examples, a few of them are given herewith. In questions of dispute, these figures should be considered in the light of standards (aërial concentration is meant) :

Ammonia:
> 0.10 per cent. will cause local symptoms.
> 0.33 per cent. can be tolerated for ½ hour.
> 1.00 per cent. may be borne by habitual workers for varying intervals.
> 10.00 per cent. may be fatal forthwith.

Benzine:

0.02 per liter will cause local symptoms.

0.05 per liter is poisonous.

Benzol:

0.015 per liter will cause local symptoms.

0.042 per liter will kill dogs in 20 minutes.

Carbon Monoxide:

0.05 per cent. is slightly poisonous.

0.25 per cent. is dangerous to new workers.

0.50 per cent. is the limit to which habitual workers may expose themselves.

Lead Oxide:

1/16 grain (estimated as lead) absorbed daily will produce symptoms in from 2 to 4 weeks. (Compare with the usual dose of strychnine!)

Zinc Oxide:

0.007 grams in 30 liters of air produced in burning pure zinc will cause brass founder's ague.

In a similar manner, maximum limits of toleration for most of the poisons used in industry have been determined and are upon record.

Classification. The writer has no intention of going into the effects and sequelæ of the various poisons used in industry. For such information the reader is referred to the list of reference works appended to this article. Suffice it to say that a handy grouping into three divisions is worth pointing out: (1) Biological poisons, having limited use in industrial callings, and controlled exposures to which usually bring about an immunity: (2) organic poisons, having extensive use in some industries, and exposure to which is unattended by any real immunity, although remarkable toleration effects do supervene (compare morphine, cocaine, etc.); and (3) inorganic poisons, which have very extensive industrial use and to which practically no immunity or toleration is established although certain ones, like arsenic, phosphorus and iodine, may have an alterative or tonic effect for a time. In fact, with the last two groups of poisons increased susceptibility is invariably the result of repeated exposures, rather than acclimation.

It is well to point out also that certain metals usually assumed to be poisonous are probably not so *per se*—copper, tin, aluminum, zinc, iron and steel. What is meant is that these are not consti-

tutional poisons, although various salts of them may have a local irritative effect when coming into contact with the skin or tissues.

Poisons may have a single, double, or triple *action* upon the person. For instance, lead chromate is an irritant at the point of entrance, a blood and constitutional poison while in the system, and an irritant at the point of elimination (kidneys, intestines). Wood alcohol gives usually no untoward effects at the point of entrance, but is a constitutional poison (nervous system) and an eliminant poison (through its change to formic acid) upon the kidneys. Turpentine is an irritant at both the point of entrance (skin or mucous membranes) and the place of elimination (kidneys and bladder), but probably not a constitutional poison. Copper sulphate is an irritant at the point of entrance, but appears to have no further toxic action in its progress or the progress of its components, through the system. Thus each poison should be considered in the light of these three possible effects upon the system, and this grouping noted by the physician, whenever he has occasion to investigate an industrial poison.

It is to be observed, also, that *mass and concentration* have a most decided effect on the resulting symptoms, a normal adult male can handle physiologically two milligrams of lead in an eight-hour day, but let the amount increase above this, or with the same poison exposure, let the day be increased to twelve hours (hence an intake of three milligrams) and he will probably show signs of intoxication before a couple of weeks. A return to the shorter day will usually be followed by a disappearance of untoward manifestations.

Age and *sex*, particularly the former, influence the result of exposure to poisons. As a general rule, youth does not tolerate any of the industrial poisons as well as middle age. Sex appears to have a limited influence, other things being equal, with a couple of important exceptions, *lead poisoning,* which afflicts the female worse, more in particular in regard to promoting abortion and miscarriages and perhaps in stigmatizing the young born of such mothers; and benzene (benzol) which affects female workers, particularly in their developmental years, especially at the time of menstruation, more than men, and in an extraordinary degree in the sub-acute and chronic forms of the poisoning. Females should never be employed where they are exposed to benzene

(benzol), either as liquid or vapor (milliners, certain shoe making processes, users of rubber cement).

The more common poisons used in the industries if we can consider the varied industries of Ohio as typical are, about in descending order of both their frequency of use and their liability to produce occupational disease, as follows: Lead, benzine (naptha, petrol, gasoline, etc.), benzene (benzol), rubber accelerators (urotropin, etc.), turpentine and similar dryers, brass or zinc in the form of fumes; acids, alkalies, wood alcohol, analin oil, carbon bisulphide, antimony, illuminating and fuel gas, sulphurated hydrogen, arsenic, phosphorus and mercury.

MISCELLANEOUS HAZARDS.

Objectionable Odors. For some workers (oil-blast furnacemen, fertilizer workers, chemical workers, etc.), nauseating odors may endanger health by affecting the appetite, causing mucous gastritis, or causing the actual vomiting of food.[37] Where odors alone are concerned, usually only particularly susceptible persons are affected. Ventilation, confinement, spraying or burning may be used to overcome these nuisances.

Disorder of the Workplace. Lack of cleanliness, accumulations of rubbish and dirt constitute definite health-hazards in a number of ways: (1) Generally speaking (only), dirt and disease coexists;[38] (2) a "dirty" place is the first place in which waste matters are accumulated and bodily excrements, especially sputum, are deposited; (3) how much dirt upon window panes, skylights, lamp globes, reflectors, walls and ceilings inhibits light and its distribution, is very little appreciated;[39] (4) waste accumulations tend to gather moisture and hence favor prolongation of germ life; (5) unkempt surroundings have a sub-conscious deteriorating effect upon the inclination to work and upon the ability to produce, and, particularly, upon the observance of health standards and health habits and morals by workers, both without, as well as within, the work place. The insistence upon a sanitary and orderly work environment is fundamentally economic from three points of view: Physiologic, psychologic, and industrial output.

Natural Desires. Very often the natural desires are the cause, directly or indirectly, of great risks to health. *Thirst* should be

especially carefully provided for in connection with workplaces by which the water supply is safe from bacterial pollution and poison content, and it should be made as inviting as possible through a proper degree of cooling and its convenience for use. All other substitute beverages should be discouraged. The devices used in the process of water purification are imperative. *Hunger* becomes a hazard when the taking of food is not properly provided for in workrooms free from poisons, dusts, odors and bacterial contamination; also, when the time factor is not physiologically observed and, finally, when the character and quantity of the food itself lacks supervision. *Cleanliness* becomes a hazard when proper and safe means are not at hand for the use of workers. The desire to be clean under such circumstances may prove a greater hazard than the remaining unclean. The attention to the natural desires brings in the consideration of the standards which have been adopted in all of our leading states and countries in regard to toilets, urinals, sewage and refuse disposal.

The desire for *rest* and the occasional demands for the temporary cessation of work requires the presence of proper seats, or of rest-rooms and an arrangement for necessary rest periods and simple remedies, especially where females are employed. The desire for *sleep* should be satisfied with provision for at least an eight hours' continuous period out of each twenty-four hours. The workers should be encouraged to make *the day the unit of routine* rather than, as is often the custom, the week, whereupon extra sleep, rest, cleanliness, diet, etc., are made features of Sunday. The desire for *recreation* should be encouraged and made recreative, and not dissipative. The recent survey of industrial health-hazards in establishments in Ohio[40] found that exposure to certain hazards classified as "bad," from the standpoint of sanitation and hygiene, existed in a very considerable proportion of establishments.[41]

The excellent little brochure put out by the Metropolitan Life Insurance Company entitled "Occupation Hazards and Diagnostic Signs" (revised 1921) considers in tabular form *nine* hazards of employment which occur in the more common hazardous occupations (alphabetically arranged) and synopsizes the main effects or symptoms of each hazard. It is a valuable aid to the busy physician.

The following recapitulation of various hazards shows the percentage of work places where the exposure was classified as "bad."

Specific health hazards	Per cent. of work places where exposure to health hazard was found to be bad.
Dust	16
Dirt	21
Dampness	1
Darkness	10
Air	18
Heat	4
Cold	2
Infections (communicable diseases)*	41
Poisons	19

Effects of Some of the Chief Hazards as Seen in Dispensary and Hospital Records. It is to be regretted that of the vast number of treating institutions in America, those which give any real attention to the matter of industrial relationships of the patients treated and make records of the same are woefully few. However, some years ago (1911-13) an opportunity in this direction was extended to the writer who made a study of 65,000 records at Rush Medical College (Central Free Dispensary) Chicago, where a good standard of records were kept, and while it was possible to determine that 15,475 persons had definite trades, of whom 5105 worked at occupations known to have definite health-hazards and had afflictions which such hazards were at least promoting, still it was not possible to associate, with any proximity, cause and effect. The experience in the Rush Medical College branch of the Chicago Tuberculosis Institute with records kept somewhat better for this purpose and involving 2500 consecutive applicants, showed that there were 875 tradespersons surrounded with definite health-hazards in their work. During the course of the inquiry 259 out of 368 tuberculous patients made complaints *when personally interviewed*, of working conditions involving four hazards: Dust, light, dampness and ventilation.

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* Included in "infections," in the above recapitulation, are particularly the dangers from promiscuous spitting upon floors in work-places by persons who are employed without physical examination and who work without medical supervision.

At the Massachusetts General Hospital facilities were established in 1913 for the careful case-study of occupational health complaints and in 1915 its Department of Industrial Research, in charge of Dr. David L. Edsall, was enabled to make what is undoubtedly the best and most scientific inquiry in America in the hospital field for afflictions due to industrial health-hazards. The report covers fifteen months during which time 482 patients with carefully compiled industrial records were covered.

ANALYSIS OF 916 EXPOSURES IN 482 PATIENTS.

Exposure	Definite symptoms	Border-line symptoms	Total
Fumes and smoke	127	196	323
Dust	106	101	207
Strains and posture	122	106	228
Skin irritants	49	12	61
Other factors	51	46	97
Totals	455	461	916

Many of these patients were subjected to more than one hazard. In 455 cases there was a clear relationship between the disease presented and the occupation. In the remaining 27 cases, the symptoms suggested that the occupation was partly or wholly responsible for the patient's condition. The table given herewith is abstracted from the Ninth Annual Report of the Hospital, pages 18 to 24, and serves to show the point.

CHIEF INDUSTRIES, TRADES AND CALLINGS AND THE MIDDLE AGED WORKER.

MORBIDITY.

The author presents here a study of the statistics made of the sick benefit association of a large steel company in Ohio of which all employes are members. It is published in the report of the Ohio Occupational Disease Survey (page 58):

The plant has always been of the very highest order in matters of sanitation, hygiene, welfare and accident prevention work, and, at the time the study was made, was easily the leader in the state in this industry. It was the only one, also, possessed of carefully compiled stati tics covering a period of years and subjected to very little fluctuation in numbers employed. The following table represents *bona fide* sickness (accidents and venereal diseases excluded).

9

*III. The Average (Yearly) Morbidity Figures in the Various Depart-
ments of an Iron and Steel Establishment During a Period of Three Years,
1911 to 1913 inclusive.*

(The greatest variation of numbers employed did not exceed 15% in
any one department.)

Departments	Average number of employes	Average number sick	Average per cent. sick
(a) *Heat Exposed.*			
Bessemer	393.3	33.0	8.39
Open hearth	145.3	7.	4.81
Rail and shape mill	500.	43.3	8.66
Blast furnaces	261.	35.	13.41
Foundry	163.3	12.7	7.77
Shelf mills	348.3	33.3	9.56
Pipe mill	1,764.7	162.	9.18
(b) *Weather Exposed.*			
Police	35.	2.7	7.62
Railroad (yards)	156.3	9.	5.76
Section hands	110.	10.	9.09
Yard labor	468.	28.7	6.13
Ore docks	99.3	8.3	9.19
Bricklayers	72.7	2.7	3.66
Building construction	106.3	9.7	9.07
(c) *Indoors* (mostly).			
Mechanical	472.3	47.7	10.09
Electrical	181.3	4.3	2.37
Miscellaneous	351.6	11.3	3.21
Total	5,619.7	460.7	8.20

The table shows the minimum amount of sickness to be expected in
an industry of this type having high attainments in sanitation and hygiene
of working quarters and medical supervision of its employes. It shows,
particularly, which departments have the most and the least sickness, and
hence where the greatest precautions are necessary. It shows, further,
figures for a number of "weather-exposed" groups of workers who are
under organized welfare and medical supervision—figures difficult to ob-
tain for these classes. It may be added in conclusion that a large percentage
of these workers are foreigners, eastern Europeans, and therefore a dif-
ficult class to instruct and supervise. The average yearly sickness for the
departments combined amounted to 8.2% of those employed at any one time.

Emmet reports an actuarial study of "Disability by Age and
Occupation,"[42] covering the actual extent of sickness (including
accidents) among 40,000 wage earners representing 42 occupa-
tions in the large national mutual association known as the
"Workmen's Sick and Death Benefit Fund of America," in exis-

CHART III.—Corrected Annual Disability Days For Each Occupation (Age Groups, 25 - 59).

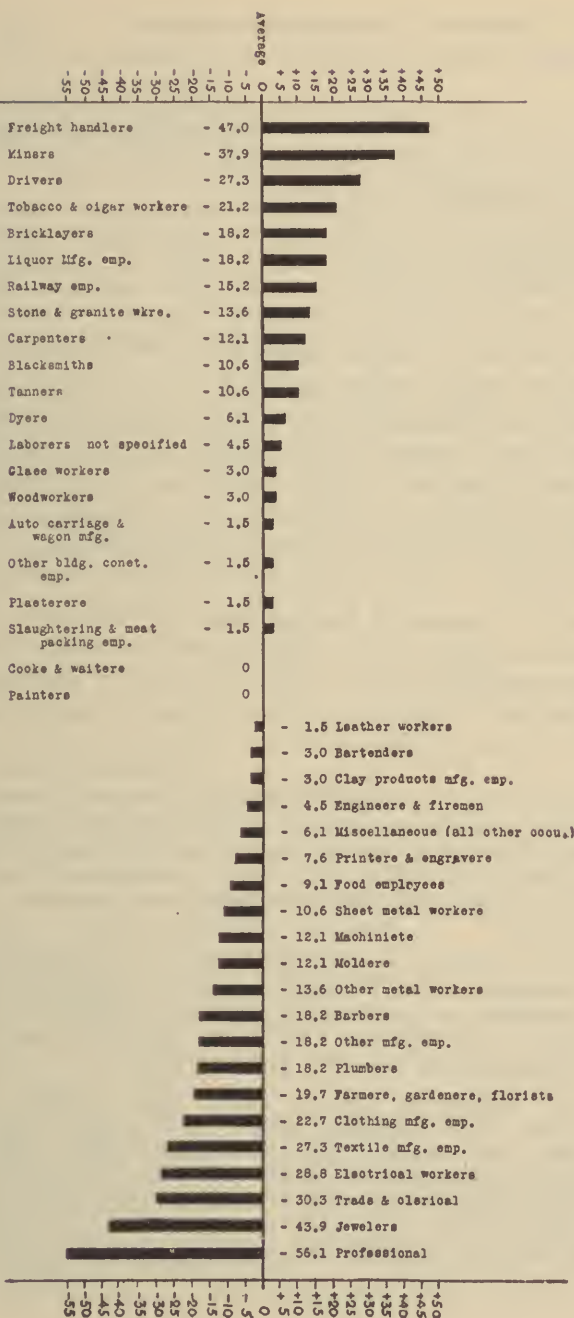| Occupation	Average Annual Number Disability Days Per Member
1. Miners	9.7
2. Freight handlers	9.6
3. Drivers	8.6
4. Railway Employees	8.4
5. Liquor Manufacturing Emp.	7.9
6. Stone & Granite	7.5
7. Bricklayers	7.1
8. Glass Workers	7.1
9. Laborers, not specified	6.9
10. Blacksmiths	6.9
11. Slaughtering & meat packing emp.	6.9
12. Tobacco & Cigars	6.8
13. Carpenters	6.7
14. Other Building Construction emp.	6.0
15. Clay Products Mfg. emp.	6.6
16. Painters	6.4
17. Dyers	6.4
18. Cooks & Waiters	6.2
19. Food employees	6.2
20. Machinists	6.1
21. Printers & Engravers	6.1
22. Woodworkers	6.1
23. Bartenders	6.0
24. Engineers & Firemen	6.0
25. Barbers	5.9
26. Auto. carriage & wagon mfg. emp.	5.9
27. Tanners	5.8
28. Leather Workers	5.8
29. Molders	5.8
30. All other occupations	5.7
31. Plasterers	5.6
32. Plumbers	5.6
33. Sheet Metal Workers	5.6
34. Other Metal Workers	5.4
35. Farmers, Gardeners, Florists	5.3
36. Other Manufacturing emp.	5.1
37. Electrical Workers	4.8
38. Trade & Clerical	4.7
39. Textile Manufacturing emp.	4.5
40. Clothing Manufacturing emp.	4.4
41. Jewelers	3.6
42. Professional	2.6
43. All occupations	6.4

tence since 1884. The society confines its disability membership almost exclusively to males, eighteen years of age and over. The average age of the membership is forty-three years. The study represents the five-year period ending December 31, 1916, and is therefore free from such influences as the influenza pandemic. The society pays a sick benefit beginning with the filing of the physician's disability certificate (usually the first day). There is, therefore, no waiting period. The study does not include sickness extending over fifty-two weeks, which was negligible for the purpose at hand. Dr. Emmet states that this is the first official and exact measurement of disability among wage earners.

The average annual number of disability days was 6.6, this being only for days compensated, and not for total days of sickness. Emmet points out that this approximates closely the estimates made in connection with the sickness surveys of the Metropolitan Life Insurance Co., 6.8 days per employe per year. The man from forty-five to forty-nine years of age shows the average disability (i.e., 6.6 days). Up to this age-group disability is slightly below this average (4.8 to 5.2 days). Beyond this age-group there is an unmistakable tendency for sickness to increase with age. The extent of the disability in the age-group fifty-five to fifty-nine is about one-third greater than the average (9.0 days), and in age-group sixty to sixty-four more than four-fifths greater (12.0 days). Emmet's Chart III and Chart IV illustrate graphically the varying disabilities as per trade and the hazardous index of each occupation. In some, accidents are the chief factor (freight handlers, miners), in others, sickness, such as the high rate of tuberculosis (tobacco and cigar workers). Thus, Emmet shows that some occupations support themselves in the fund (those, roughly, occurring at the center of Chart IV) while others (e.g. barbers) produced an income which was used to support an occupation (e.g. miners) which had an extra disability rate.

Attention is next directed to an arrangement of mortality statistics somewhat different from forms customarily shown.[43] An analysis of the mortality statistics of 210,507 persons engaged in one hundred and forty occupations in the registration area of the United States exhibits the percentages for the census year 1909 (the only year in which complete tables were published).

The deviations in the number of disability days from the average for all occupations is an index as to the hazards of the various occupations. It is highest for freight handlers, and lowest among professional employes.

Occupation	Deviation
Freight handlers	- 47.0
Miners	- 37.9
Drivers	- 27.3
Tobacco & cigar workers	- 21.2
Bricklayers	- 18.2
Liquor Mfg. emp.	- 18.2
Railway emp.	- 15.2
Stone & granite wkrs.	- 13.6
Carpenters	- 12.1
Blacksmiths	- 10.6
Tanners	- 10.6
Dyers	- 6.1
Laborers not specified	- 4.5
Glass workers	- 3.0
Woodworkers	- 3.0
Auto carriage & wagon mfg.	- 1.5
Other bldg. const. emp.	- 1.5
Plasterers	- 1.5
Slaughtering & meat packing emp.	- 1.5
Cooks & waiters	0
Painters	0
Leather workers	- 1.5
Bartenders	- 3.0
Clay products mfg. emp.	- 3.0
Engineers & firemen	- 4.5
Miscellaneous (all other occu.)	- 6.1
Printers & engravers	- 7.6
Food employees	- 9.1
Sheet metal workers	- 10.6
Machinists	- 12.1
Molders	- 12.1
Other metal workers	- 13.6
Barbers	- 18.2
Other mfg. emp.	- 18.2
Plumbers	- 18.2
Farmers, gardeners, florists	- 19.7
Clothing mfg. emp.	- 22.7
Textile mfg. emp.	- 27.3
Electrical workers	- 28.8
Trade & clerical	- 30.3
Jewelers	- 43.9
Professional	- 56.1

MORTALITY AMONG OCCUPIED MALES*

	Those in agricultural pursuits. Percentage of all deaths	Those in 131 trades and callings. Percentage of all deaths
Deaths from preventable causes (⅚ are diseases) †.	27.4	43.0
Deaths from *degenerative* diseases (under 70 years of age) ‡	26.5	31.2
Total deaths after 70 years of age	35.9	13.4

From this we see a marked difference in the prevalence of certain wasteful death causes between the two classes compared. We also note that the agriculturist stands a one-in-three chance of reaching old age (seventy years), while the others' probability is but little better than one in eight. None can fail to grasp the significance of this table. To disclaim the importance of these figures on the basis of incorrect diagnosis and uncertainty of occupation is unjust. The fact that only the registration area is included, and the recency of the reports answer the first point. As to the second feature, Wilbur[44] has shown that where another or previous occupation could have been a factor, it amounts to less than 1 per cent., which is less than ordinary errors of transcription.

*"Occupied males" include professional callings, officials and proprietors, those engaged in domestic and personal services as well as those we ordinarily term real workers, namely, those in trade and transportation, manufacturing and mechanical pursuits, miners, quarrymen, etc., composing a total of 140 chief occupations—including those engaged in nine agricultural pursuits.

†"Deaths from preventable causes" include typhoid fever, pulmonary tuberculosis, pneumonia (under 70 years), alcohol, lead poisoning, other occupational poisonings, suicide, accidental poisonings, accidents and injuries, rheumatism, bronchitis, pleurisy and hernia—for the last four, only such deaths as have occurred under 70 years are included.

‡"Deaths from degenerative diseases" include cancer, diabetes, apoplexy, heart disease, "other circulatory diseases" (4,858) asthma, cirrhosis of the liver, "other liver diseases" (880), and Bright's disease. There remain in the census classification 27,105 deaths from peritonitis, appendicitis, "other respiratory, digestive, nervous" and "all other causes," a large percentage of which were also undoubtedly preventable or prematurely degenerative, but which are not taken into consideration in the classification given above.

Effect of occupation on mortality[45] (as derived by medico-actuarial experience) is presented in the table which follows.

"The statistics as below extracted include not only policies issued at the regular rate of premium, but those also which by reason of occupation alone had been charged with an extra premium, placed in a special dividend class, limited to a high premium plan, or issued subject to lien against the insurance. Over-weight or under-weight cases were included provided the departure from the average weight did not in itself make the policy holder a substandard risk. Cases of medical impairment were also included under the same conditions, but if the departure from the average or the medical impairment were of such amount as to make the insured a substandard risk, the data were excluded from the study of occupations."

The table is made up of two lists or groups "Required" and "Optional," the latter being those which were not considered of much importance by the majority of the companies, or for which the committee did not believe that a sufficient amount of data existed at the present time. The companies were requested, but not required, to furnish their data for the "Optional" occupations.

TABLE—GENERAL SUMMARY.

1. "Required" Occupations.

Occupation	Ratio of actual to expected deaths Per cent.
Army: Commissioned officers excluding chaplains, physicians, surgeons and paymasters	131
Automobile Industry:.Proprietors and salesmen	117
Repairmen and machinists	102
Chauffeurs, non-racing, not including testers and demonstrators	108
Bakers: Journeymen	98
Cooks and chefs in hotels and restaurants (men)	152
Druggists, retail: Proprietors and employees	108
Electric light, heat and power systems:	
Superintendents, managers, and chief engineers	93
Electrical engineers handling live wires	105
Stationary engineers and firemen	92
Linemen (pole climbers) and arc light trimmers	142
Fire departments, city:	
Lieutenants, captains, chiefs, and assistant chiefs	121
Firemen, laddermen, pipemen and hosemen	148
Drivers, engineers, stokers and truckmen	124
Glass Industry: Glass blowers not using machinery, excluding foremen and superintendents	121
Bevelers, grinders, engravers and cutters of glass, excluding foremen and superintendents	146
Hatters, journeymen, excluding straw hatters	134

Ratio of actual to expected deaths

Occupation	Per cent.
Life-saving corps: Officers and men	96
Liquor business: Hotels with bar, proprietors, superintendents and managers not attending bar	135
Proprietors, superintendents and managers attending bar	178
Saloons, billiard rooms, pool rooms and bowling alleys with bar, proprietors not attending bar	182
Proprietors and managers attending bar	173
Breweries, proprietors, managers and superintendents	135
Clerks	130
Foremen, maltsters, beer-pump repairers and journeymen	152
Distilleries: Proprietors, managers and superintendents	85
Traveling salesmen and collectors for distilleries, breweries and wholesale liquor houses (excluding life-long total abstainers)	128
Wholesale liquor houses: Proprietors and managers	112
Clerks	112
Restaurants with bar: Proprietors, superintendents and managers not attending bar	152
Waiters in hotels, restaurants and clubs where liquor is served	177
Marine: Officers and engineers on steamers on Great Lakes	118
Metal Working: Metal grinding and polishing—cutlers, scissor-grinders, axe, plow, and other steel grinders, excluding foremen and superintendents	117
Burnishers, buffers, finishers and polishers of metal, excluding foremen and superintendents	101
Blast Furnaces: Foremen, assistant foremen and working superintendents	110
Forgemen, foundrymen and molders, excluding foremen and superintendents	118
Rolling mill employees (hot iron workers only), excluding foremen and superintendents	117
Mining: Underground mines (supervision)—engineers, superintendents and managers occasionally going underground (excluding coal mines)	135
Superintendents and managers of coal mines occasionally going underground	106
Surface mines, placer, drift, hydraulic, etc.: Foremen and bosses	160
Working miners	208
Underground mines other than coal mines:	
Foremen and bosses	168
Working miners	226
Coal Mines: Working coal miners (Anthracite)	191
Working coal miners (Bituminous)	132
Navy: Commissioned officers (excluding chaplains, physicians, surgeons and paymasters)	152
Nursing: Trained male nurses	122
Trained female nurses	81

<div align="right">Ratio of actual to expected deaths</div>

Occupation   Per cent.

Police and Prisons: City policemen 139

   Marshals, sheriffs and constables (excluding chief sheriffs not
      exposed to hazard from occupation) 134

   Jailers, wardens and prison guards 109

Potteries: Employes molding potters' clay (excluding foremen
      and superintendents) 170

   All other employes (excluding foremen, superintendents and
      office employes and those glazing pottery) 93

Railways: Passenger trainmen (not conductors) excluding issues
      prior to 1890 137

   Locomotive engineers, excluding issues prior to 1890 160

   Locomotive firemen, excluding issues prior to 1890 190

   Check clerks, freight inspectors, car inspectors, car sealers, yard
      clerks and yard masters 141

   Track supervisors and foremen and section foremen 126

Sawyers in Saw-mills, excluding those working part of the year in
      other occupations 120

Smelter Works: Foremen and workmen (millmen) 114

Structural iron works (including housesmiths and bridge-builders) 168

Teamsters (excluding liquor trade) 116

Theaters: Actors (including vaudeville performers, but excluding
      acrobats and circus performers) 145

   Proprietors, managers and treasurers of theaters, music halls and
      vaudeville houses 136

2. "Optional" Occupations.

Barbers and hairdressers, journeymen 109

Bricklayers 108

Butchers (retail), journeymen 96

Blacksmiths who occasionally shoe horses, and horse-shoers 81

Cigarmakers (men) 108

Cotton factory operatives (men) 108

Domestic servants (women) 127

Firemen (stationary), not connected with mining or other hazardous
      pursuits 110

Fishermen in-shore 73

Groceries with bar: Proprietors 164

Janitors 112

Jewelers, journeymen 76

Livery stables: Proprietors 126

Lumbermen 105

Millers, journeymen 105

Motormen on street electric lines 131

Oil fields: Drillers, pumpmen and gaugers 71

Painters (house), journeymen 111

Paper and pulp mill operatives (men) 101

Plumbers and steam-fitters, journeymen 99

	Ratio of actual to expected deaths
Occupation	Per cent.
Printing: Compositors, journeymen	102
Printing: Pressmen, journeymen	117
Railway mail clerks and express messengers	85
Shoe manufacture operatives (men)	101
Stone-cutters, journeymen	214
Steam vessels: Officers and engineers in coastwise trade excluding those traveling to the tropics	138
Officers on steamers on rivers, lakes, sounds and harbors excluding Great Lakes	107
Officers and engineers on ocean steamers	156
Tailors, journeymen	99
Tanners, journeymen	83
Undertakers and embalmers: Proprietors	95
Veterinary surgeons	80
Woolen mill operatives (men)	113

Because of certain practical relationships and of completeness, no deductions surpass those of Bertillon[46] for the city of Paris, as given in his paper before the XVth International Congress, on Hygiene and Demography, from which the following has been selected:

All employments are grouped according to the hazards to which workers are exposed, as follows: (1) alcohol, (2) lead poisoning, (3) organic wastes, (4) the weather, and (5) confined positions. The highest mortality is found in the trades exposing the workmen to alcohol and to lead poisoning. The five groups above given are subdivided into 100 distinct vocations. Bertillon finds that:

The *principal causes of mortality* prove to be alcoholism, diseases of the lungs, heart, liver and nervous system, diabetes, suicide and accidents.

The *most healthful vocations* are those carried on in the open air, provided they permit movement. Those restricting freedom of movement, though carried on in the open air, are harmful.

Mortality was found to be *lowest* among railway engine men, wood sawyers, teachers, attorneys and clergymen.

Mortality was found to be *highest* among day laborers, stevedores, miners, stone cutters, tradespeople, coachmen, grooms, footboys, jockeys, petty shopkeepers, printers, blacksmiths, tilers, glassmakers, messengers, cutlers, chimney sweeps, barbers and musicians.

Suicide was found to be rare among clergymen, officers, railway employes, mail and telegraph employes, shipbuilders, wood sawyers, employes in gas works and booksellers. It was also quite rare among tanners, masons, farmers, road builders, boatmen, fishermen, wheelwrights and miners.

The *highest suicide rate* was found among saloon keepers, salespersons in retail stores, chimney sweeps, butchers, fruiterers and musicians. It was also frequent among brewers, tilers, petty shopkeepers, cutlers, hatters,

barbers, tradespeople, clock makers, jewelers, domestics, dairymen, sellers of fish and poultry, gardeners, commercial travelers, attorneys, physicians and pharmacists.

THE OCCUPATIONAL DISEASES IN IMPAIRMENTS OF MIDDLE LIFE.

Forms and Frequency. 1. *Deaths* from occupational diseases are very rare. This is because some secondary disease terminates the affliction which occupation first produced.

2. *Specific cases* or instances of occupational diseases are fairly common; for instance, in certain industries such as the manufacture or repair of storage batteries and the manufacture of lead compounds. Certain trades and callings have a high rate; for instance, those engaged in the mixing or batch rooms of a large number of industries in which poisonous ingredients are handled. A careful analysis of 100 union painters in Chicago showed that sixty per cent. were suffering from lead poisoning. In this country a large percentage of those engaged in caisson work suffer from the "chokes," "bends" or "staggers" of compressed air illness.

3. *Diseases partly occupational* are very common; such as asthma or bronchitis, tuberculosis, Bright's disease, organic heart disease, circulatory hypertension, etc.

4. *Occupational health complaints,* which are really not yet diseases, are almost universal. These represent strains, physiological strains in which normal toleration is strained to the utmost, indeed, over into the field of true disease. Examples are: Headache from eyestrain; dyspepsia, constipation, and sluggishness from inactivity and sedentary work; aches, pains, and numbness from the too strenuous use of hands, or arms, back or limbs; slouching postures or attitudes, due to inability to change positions frequently and thus remove strain.

It is noteworthy that all forms of occupational afflictions, whether truly occupational or only partly so, are invariably greatest where industrial health-hazards are found to be greatest. *They are most frequent in the least natural occupations.* They are found to have been particularly frequent when in the hospitals and dispensaries we go into the past histories of those suffering from chronic degenerative diseases.

Classification. The classification of occupational afflictions is difficult. The following scheme seems most feasible to me:

I. *Specific Occupational Diseases.* These are truly occupational unless proven otherwise. The diagnosis itself or knowledge of the place of origin usually indicated that they are occupational. Any doubt is expelled if upon investigation the occupational hazards are actually found to exist which are known to produce the affliction in question. It is worth noting that on this basis British laws, and indeed those of Ontario, place the burden of proof of any other cause than occupation upon the employer for a certain list of some twenty odd afflictions.

Under the head of *specific occupational diseases* for example, are to be classed:

1. The *poisons,* such as lead, evidenced by definite signs as colic, paralysis, insanity.

2. *Mechanical irritants,* such as mineral dust, producing eczema, or iron-dust producing the lung condition known as siderosis.

3. *Friction,* such as constant pressure against the body or rubbing, producing callosities, worn teeth, or certain bony overgrowths.

4. *Fatigue,* especially selfsame movements often repeated or prolonged strain; for instance, sewing, writing, holding pneumatic tools, constant postures—these finally producing deformities, neuroses, nervous breakdown.

5. *Infections.* Not many under this head, but occasionally certain ones are specifically occupational, such as anthrax from hides and wool, glanders from the horse, lumpy jaw from cattle, lockjaw from industrial wounds, typhoid fever limited to the employes of a certain plant where the drinking water supply is found polluted, and the very common "machinists' boils" due to oils, cutting compounds and lubricants.

6. *Diseases following injuries* at work, such as infections, deformities and fibroses which become, therefore, occupational diseases. Fortunately, the "first aid" movement has greatly reduced this class of occupational afflictions. Note, however, that the Massachusetts Supreme Court has held that total incapacity due to a latent disease, syphilis, re-awakened by an injury and resulting in insanity, must be compensated.

7. Extremes of certain environmental conditions of work: (*a*) Excessive *light,* such as the suddenly inflamed eyes from electric

flashes, called electrica ophthalmia; or prolonged work in deficient light producing nystagmus or dancing pupils, largely a disease of miners.   (*b*) High *temperature,* producing thermic fever and heat stroke; or low temperature, producing local afflictions, such as frost bites, and general afflictions known as chilling and congestion in certain organs or parts followed by typical diseases of these parts.   (*c*) *Noise,* especially reverberating noises, producing deafness.   (*d*) *Atmospheric pressures,* producing the various forms of compressed air illness, or sudden concussions, producing ruptured ear drums, or rarefactions, as in aviators, producing giddiness and perhaps temporary unconsciousness.

So much for the specific occupational diseases, the frequency of which we all know to be common when we consider the whole list.

II. *Diseases Partly Occupational.*   These, of course, make up the vast majority of cases which are of interest to the industrial physician and to all.   They are due to a repeated subjection to environmental hazards of ordinary severity or brief duration.   The same hazards occur outside of industry and may be found, perhaps, in the housing, the recreation, or indeed, the geographical location.   These latter, industry will never control completely, whereas it is possible, we believe, to eliminate practically every industrial cause.

From this class of diseases partly occupational, come, especially, the *chronic degenerative diseases* which particularly afflict America and crowd hospitals and dispensaries with persons who are over forty years of age, and in almost the same proportion cause us to find on the job a very vast majority who are under forty years of age—a marked contrast to the British system which is said to make the most efficient coal miner, for instance, the man who is fifty-seven years of age.

The U. S. Bureau of Labor Statistics (No. 195, issued July, 1916) showed that during the great depression of March and April, 1915, 17 per cent. of those unemployed in Boston were sick or disabled, and that for 68,084 unemployed in sixteen cities in the East and Middle West, 11 per cent. were prevented from working on account of sickness or disability.   Diseases partly occupational are usually fibrotic, that is, due to tissue changes in which fibrous tissues take the place of normal, healthy cells and delicate tissues.

These diseases are divided into two groups:

I. *Systemic:*

Nervous and Mental.	Muscular.
Circulatory.	Osseous.
Urinary.	Cutaneous.
Respiratory.	Special sense (sight, hearing, etc.).
Digestive.	Glands of internal secretion.

II. *Constitutional:* This group represents depletion diseases, or those due to the perversion of functions of vital organs and parts. It includes among others anemia, emaciation, obesity, gout, diabetes, chronic rheumatism, cancer, certain infections, and the like.

SPECIFIC OCCUPATIONAL DISEASES.

A number of States have now compiled statistics concerning the occurrence of occupational diseases: New Jersey, Massachusetts, Illinois, Nebraska, Maryland, New York, and Ohio. As there is a difference between the findings of a definite survey for diseases of any kind and a compilation of those which may be reported voluntarily or by law, I give the two accompanying tables. A summary is given herewith of the cases of occupational diseases found during the course of the survey in Ohio (these were all actually reported within the space of twelve months— 1914-15.)[47]

OCCUPATIONAL DISEASES FOUND DURING A STATE SURVEY, OHIO, 1914 TO 1915.

Benzine and benzol poisoning	33
Skin affections	39
Brass poisoning	124
*Respiratory afflictions (tuberculosis 301)	345
Lead poisoning (in addition, 138 tentative cases. Of the total only 21 were engaged in non-manufacturing processes, *e.g.,* house painters)	544
Miscellaneous diseases	119

Summary:

Total positive cases	1204
Total tentative cases	211
Total	1415

*While these "respiratory afflictions" were as nearly typically occupational as could be ascertained and, today would undoubtedly come under the Phthisis Compensation Act of Great Britain, and the Union of South Africa, they are hardly "specific" in the restricted sense we use the word in connection with the other afflictions tabulated.

CHIEF SOURCES OF POISON CASES:

Lead Poisoning: Electrical supplies 107
    Automobiles and parts 79
    Potteries 61
    Rubber 43
    Carriages, wagons and parts 42
    Chemical manufacturing 36
    Paint and varnish manufacturing 25
    Painting (non-manufacturing) 21
    Manufacturing of lead articles 18
    Coffins and vaults 13
    Miscellaneous 100
                                                             ———
        Total 545

Benzine poisoning: Rubber 9
    Dry cleaning and dyeing 7
    Paint and varnish manufacturing 4
    Agricultural implements (painting) 3
    Boots and shoes 2
    Miscellaneous 8
                                                              ——
        Total 33

Brass poisoning: Brass foundries, brazing establishments, polishing and
    buffing, galvanizing.
Turpentine poisoning: Painting, varnishing, decorating and manufacture of
    paints and varnishes.
Miscellaneous:
    Not much poisoning due to wood alcohol, arsenic, phosphorus.
Considerable poisoning due to alkalies, acids.
Much siderosis, pneumonoconiosis and tuberculosis.   Also—
    Heat prostrations, exhaustions, heat cramps and colic.
    Fatigue from monotonous applications.
    Eyestrain.
    Deafness from noise.
    Dermatitis.
    Flat foot.
    Rheumatism.
    Industrial alcoholism.
Less common, but peculiar affections:
    Carbon cancers—dry batteries, oil refining, pitch, tar, etc.
    Appendicitis
    Acid caries of the teeth.
    Nose-bleed from alkalies—glass workers, salt workers, soap workers.
    Caisson illness.
    Visual affections—keratitis, light blindness, cataracts, etc.
    Tabacosis.
    Venereal disease spread.
    Chronic gassing leading to mental deterioration.
    Aniline poisoning—rubber workers, printers and pressroom workers.

The total occupational diseases officially reported to the Ohio State Department of Health (including all but the "respiratory afflictions" enumerated in the preceding table) during a period for eight years ending May 31, 1921, are shown in the following table:

TOTAL (SPECIFIC) OCCUPATIONAL DISEASES REPORTED IN OHIO. FOR EIGHT YEARS, 1913 TO 1921.

Disease	No. of cases	Chief sources
Lead poisoning	989	Mfg. of storage batteries.
Dermatitis	499	Mfg. of rubber goods.
Brass or zinc poisoning	131	Brass foundries.
Carbon monoxide poisoning	101	Steel works.
Anilin and derivatives, poisons	88	Mfg. of rubber.
Furunculosis	47	Machinists (lubricating oils)
Benzine poisoning	39	Mfg. or rubber; dry cleaning establishment.
Arsenic poisoning	20	Mfg. of insecticides; glass works.
Wood alcohol poisoning	16	(scattered)
Fallen arches ("flat foot")*	44	Nurses.
Others—chiefly poisons	42	(scattered)
Others—non-compensable*	45	(scattered)
Total	2062	

THE SYSTEMIC AND ORGANIC DISEASES IN RELATION TO OCCUPATION.

Morbidity.

Considering pathological conditions only, a classification of diseases which may arise from occupational causes may be made as follows:[48]

CLASSIFICATION OF DISEASES.

I. Diseases of the Respiratory System:
   (a) Due to hard inorganic dusts; bronchitis, emphysema, pneumokoniosis (cirrhosis of the lungs).
   (b) Due to soft organic dusts; rhinitis, coryza, laryngitis, acute and chronic bronchitis, asthma, lung abscess.
   (c) Associated diseases, tuberculosis, pneumonia, pleurisy.

II. Diseases of the Circulatory System:
   Hypertrophy of the heart, arteriosclerosis, aneurysm, varicose veins, anemia.

*Not compensable according to a new *Act* which became effective for compensating a certain list of fifteen occupational afflictions, August, 1921.

III. Diseases of the Kidneys:
   Chronic Bright's disease (chronic interstital nephritis).

IV. Diseases of the Alimentary System:
   Chronic dyspepsia, chronic gastritis, gastric ulcer, chronic constipation, chronic enteritis.

V. Diseases of the Skin:
   Pruritus, dermatitis, ulcers, eczema, furunculosis, chronic fissures, epithelioma, etc.

VI. Diseases of the Nerves and Muscles:
   Paralysis, spasm (tic), tremors, cramp, pain, neuritis, neuralgia, sciatica, muscular atrophy, insomnia, headache.

VII. Diseases of the Eye and Ear:
   Conjunctivitis, retinitis, optic neuritis, deafness, etc.

VIII. Diseases of the Bones:
   Necrosis of the jaw and nasal septum.

In a study of the cases admitted to Cook County Hospital, Chicago, during the year 1913, the writer[49] found that there were 11,022 adult medical cases, of whom 2866 or 27 per cent., were engaged in definite trades. So far as the hospital records were concerned, the term "laborer" was found to apply to practically all occupations, as it still does in most hospital records. Some general conclusions were deduced, however, the principal one being that almost any medical complaint might be occupational. This is especially so when the diagnosis is made of any of the following: Dermatitis, eczema, bronchitis, tuberculosis, heat-exhaustion, tetanus, flatfoot, lumbago, rheumatism, constipation, gastritis, pancreatitis, appendicitis, nephritis, neuritis, arteriosclerosis, and particularly, neurasthenia.

In 1915 the Life Extension Institute[50] examined 1000 employes of a large motor company with results shown in the table herewith.

"The institute has examined many thousands of individuals throughout the country, but I have selected two special groups of 1000 each, one sedentary or commercial, the other active or industrial, examined under conditions homogeneous as to technic, standards, and methods, with the findings continually checked under my personal supervision. Whatever interpretation may be put on these figures as to their significance, I can vouch for the accuracy of the findings according to standards of technic approved by the world's best authorities. Either our tests of these conditions must be revised or we must accept the testimony of the

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figures that the majority of supposedly healthy active workers in various walks of life are more or less impaired and physically below their attainable condition of physical well being.

ANALYSIS OF PHYSICAL EXAMINATION OF 1,000 INDUSTRIAL WORKERS (FOREMEN AND SKILLED WORKERS) IN A LARGE DETROIT MOTOR COMPANY, AND COMPARISON WITH THE RESULTS OF 1,000 EXAMINATIONS OF EMPLOYES OF BANKS, TRUST COMPANIES, AND COMMERCIAL HOUSES IN NEW YORK CITY.

	Detroit Motor Co. industrial	New York commercial
Employes	1,000	1,000
Average age ....years	32.7	27
	Per cent.	Per cent.
Perfect on examination. No physical impairment found, and no advice for correction of living habits needed	00	1
Imperfect on examination. Advice needed regarding physical condition or living habits ..	100	99
Advised to seek medical treatment	69	81

(Of those referred to physician, there were aware of impairment in each group only about 10 per cent.)

Those found imperfect, either in physical condition or manner of living, were classified as follows: (These percentages refer to individuals, and are of the total number examined.)

Minor.	Per cent.	Per cent.
Advice needed regarding living habits or physical conditions, but immediate treatment not required	31.1	17.7
Moderately impaired.		
Referred to physician for treatment and report sent to physician	22.9	18.5
No physician, or none mentioned. Urged to seek medical treatment or guidance	39.9	58.
Seriously impaired.		
Referred to physician for treatment and report sent to physician	3.6	2.
No physician, or none given. Urged to seek medical treatment	2.5	2.8

ANALYSIS OF IMPAIRMENTS.

These percentages are of the total number examined. As many had several impairments, the total of the percentages exceeds 100. In other words, these percentages are not mutually exclusive, but overlap.

	Per cent.	Per cent.
Moderate to serious.		
Organic heart	3.5*	16.2
Moderately to seriously thickened arteries (radials, brachials, and others)	24.65⎫	42.4†
Slightly thickened arteries (chiefly radials)	29. ⎭	
High or low blood pressure	23.1	26.0
Urinary—albumin, sugar, casts	45.6‡	39.8
Combined urinary and other serious impairments	26.6	24.0
Total urinary and circulatory impairments	72.3	
Nervous	.3	1.1
Lungs	5.7	2.9
Venereal,** syphilis	1.4	0.3
gonorrhea	0.5	
Minor to moderate.		
Functional circulatory—rapid, slow, irregular pulse	21.6	14.8
Minor urinary—indican, bile crystals, etc.	26.6	20.8
Digestive disturbances	9.0	7.3
Constipation	14.7	17.2
Nose, throat, respiratory	42.	28.5
Ears	30.3	20.3
Teeth and gums††	69.5	47.8
Anemia	0.4	2.7
Skin	6.8	9.1
Errors in diet	54.1	59.8
Errors in personal hygiene	50.5	54.0
Physical defects.		
Faulty vision, not fully corrected	41.	31.1
Flat foot	2.3	4.3
Faulty posture	18.1	17.7
Rupture, no truss	2.4	1.8
Overweight (25 per cent.)	12.8	3.2
Underweight (25 per cent.)	7.7	15.1
Unclassified	16.5	10.1

* These men had previously been examined before employment for gross heart defects.

† This figure represents all grades of thickening. No subdivision was then attempted in classification.

‡ These men were taken right from their work and examined during the heated term in July, which may possibly account for this high percentage.

** Very few Wassermann tests were made, but careful search for specific history, lesions, or nervous impairment was made. No bacteriological examinations were made for gonorrhea. While these figures are obviously too low, it must be admitted that there was no physical evidence of widespread venereal infection in these groups. The urine was examined microscopically in every case, and should have revealed evidence of urethral discharge or active infection, even without bacteriological examinations.

†† Teeth .... 14.27 per cent.
   Gums .... 14.07 per cent.
   Both .... 41.01 per cent.

"The figures for organic heart disease are low in the Detroit industrial group because these men were all examined for gross cardiac lesions by the Company's physician on application and those most seriously affected given some different form of employment; the entrance examination at the plant being not for the purpose of excluding men from employment, but to give them employment adapted to their conditions.

"Attention is at once rivetted on the high percentage of urinary abnormalities and the even greater proportion of men showing arterial changes.

"To clinicians accustomed to deal with the frankly sick, these figures may seem absurdly high. They are much higher than we found at the outset of our work before the technic of our staff had become highly developed and standardized. They are far higher than we anticipated, although I was prepared, by statistical evidence and long experience in the examination and valuation of supposedly healthy lives, for a high percentage of impairment."

The extent of physical impairments of industrial groups having an average age of 34 for men (and 25 for women) is shown in a table devised by the Life Extension Institute in "How to Live" (15th edition, p. 402) where 10,000 cases distributed among industrial, commercial and insurance groups are presented. The industrial men's group showed grades of physical impairments as follows: slight 10 per cent.; moderate 76 per cent.; advanced 14 per cent.; the women's industrial group: Slight 23 per cent.; moderate 73 per cent.; and advanced 4 per cent.

ANALYSIS OF IMPAIRMENTS FOUND IN EXAMINATION OF INDUSTRIAL AND COMMERCIAL EMPLOYES BY LIFE EXTENSION INSTITUTE.[51]

These percentages are of the total number of individuals examined. As many individuals had several impairments, the total of the percentages exceeds 100. In other words, these percentages are not mutually exclusive, but overlap.

Minor to moderate.   Per cent.

    Personal hygiene errors 86

    Urine, slight changes 75

    Dietetic errors 69

    Nose, throat, bronchial (slight changes) 66

    Arteries, slight changes 42

    Teeth and gums, slight defects 42

Minor to moderate (continued).   Per cent.

Constipation 33
Circulation, slight functional disturbance 30
Digestive tract, signs and symptoms 29
Skin affections 28
Ear defects 27
Anemia 15
Nervous affections, functional 3
Goiter 3
Unclassified 27

Moderate to serious.

Arteries, moderate thickening 25
Blood-pressure, moderate fluctuation 23
Urinary changes with important impairments 33
Nose, throat and bronchial, marked changes 17
Heart, moderate defects 15
Teeth and gums, marked infection 14
Heart, blood-vessels and kidney changes 12
Lungs, doubtful signs 9
Blood-pressure, markedly increased (above 175) 3
Blood-pressure, markedly low (below 100) 2
Heart, advanced defects 1
Tuberculosis, positive signs 0.3
Goiter, with symptoms 0.07
Nervous affection, marked organic 0.07
Gonorrhea 0.35
Syphilis 0.21

Structural defects.

Faulty vision (uncorrected) 53
Posture, faulty 44
Flat foot and other defects 21
Weak inguinal rings 6
Underweight (extreme) 6
Overweight (extreme) 5
Rupture, with truss 3
Rupture, without truss 1

In analyzing the causes of industrial absenteeism, Quinby[52] found in a study of 6700 employes of the Hood Rubber Co. (Jan. 1, 1919, to April 30, 1921), 35 per cent. of whom were females, and 77 per cent. of whom were between 20 and 50 years of age, that sickness and accidents accounted for 41 per cent. (6.61 days per year per employe) of the total time lost, while personal reasons were responsible for 59 per cent. Single employes lost much less time than married persons, and single males 40 per cent less than single females. Widowed and divorced fe-

males lost 154 per cent. more, and married females 175 per cent. more, than single males. Sickness at home accounted for part of the excess on the part of married persons.

Quinby found, in the analysis of industrial absenteeism studied by him (*loc. cit.*), that the causes were divided systemically as follows (days per year):

General diseases	1.46
Respiratory diseases	1.26
Digestive diseases	1.11
Ill-defined diseases	1.09
Osseo-muscular diseases	0.32
Nervous and special senses	0.22
Circulatory diseases	0.16
Genito-urinary (non-venereal)	0.15
Skin and cellular tissues	0.09
Puerperal state	0.05
Malformations	0.005

For the days for individual diseases, the more important were:

Influenza	0.718
Colds	.53
Tonsillitis	.341
Bronchitis	.312
Pulmonary tuberculosis	.24
Rheumatism	.235
Appendicitis	.171
Pneumonia (both types)	.169
Pleurisy	.095
Hernia	.091

It is interesting to note that females lost practically twice as much time as males on account of *influenza, colds* and *tonsillitis;* that *pulmonary tuberculosis, rheumatism and accidents* was nearly the same in both sexes; while males lost more than twice as much time as females from *broncho-* and *lobar pneumonia.*

Mortality.

Dublin[53] lists the causes of death which predominate at the advanced ages, namely, cancer, diabetes, apoplexy, organic heart disease, diseases of the arteries, cirrhosis of the liver and Bright's disease with their increases in incidence during the last ten years as shown in the accompanying table. "It is significant that, together, these seven causes account for more than one-half of the deaths after the age of forty."

DEATH-RATE PER 100,000 OF POPULATION FOR CERTAIN CAUSES
OF DEATH, MALE AND FEMALE COMBINED.
(REGISTRATION STATES AS CONSTITUTED IN 1900.)

Cause of death	1900	1910	Per cent. increase
1. Cancer (all forms)	63.5	82.9	30.6
2. Diabetes	11.0	17.6	60.0
3. Cerebral hemorrhage and apoplexy	72.5	86.1	18.8
4. Organic diseases of the heart	116.0	161.6	39.3
5. Diseases of arteries	5.2	25.8	396.2
6. Cirrhosis of liver	12.6	14.4	14.3
7. Bright's disease	81.0	95.7	18.1
Total	361.8	484.1	33.8

"We are warranted in concluding, therefore, in spite of the lack of absolutely accurate data, that the trend of our mortality in middle life is at present unfavorable and that this condition is accompanied by an increasing incidence of the degenerative diseases." Dublin claims that the underlying causes hereof are: (1) effects of alcoholism, (2) deleterious effects of modern conditions of industry, and (3) the changing character of the nativity and racial complexion of the nation due largely to immigration.

He further states[54] "Of the three main groups of the white population in Pennsylvania and in New York, (a) native born of native parents, (b) native born of foreign or mixed parentage, and (c) foreign born, the first has the lowest mortality. This is true for both sexes and for virtually every age period, but is most marked at the adult ages.

"The unfavorable conditions of life and work among foreign races to which attention was directed in the study for New York are found to prevail in Pennsylvania as well. The facts emphasize the necessity for special public health work for the people of foreign origin. The much more favorable economic conditions under which they live in the United States than in their own countries should result in lower death rates. But in several instances, we found that this does not prevail; the facts indicate, on the whole, deterioration rather than improvement."

Lauck and Sydenstricker[55] state that, altogether, 56 distinct races were found by the Immigration Commission to be represented at work in the leading branches of American industry.

Almost one-half of the foreign-born workers were from Southern and Eastern Europe, the largest number of these being from Austria-Hungary, Italy, Russia, and The Balkans.

The "Occupation Mortality Statistics" of the 10th U. S. Census, 1909 in Tables VIII and IX, and 11 and 12 shows the relationship between 140 occupations and their causes of death. A glance over these is sufficient to show the great frequency of tuberculosis as the chief of all factors, while accidents and injuries prove the leaders in certain other callings. These facts have prompted me to classify these 140 occupations simply according to chief death cause in each.[56]

Of the 140 occupations employing 210,507 males, 5 are discarded because the total deaths reported in same were under 25. Of the remaining 135, the chief causes claimed the following: (Those in italics are the so-called "preventable" causes of death.)

1. *Tuberculosis* .... 90 Occupations
2. *Accidents* .... 17 Occupations
3. Heart disease .... 25 Occupations
4. Bright's disease .... 3 Occupations

        Total .... 135 Occupations

Of the 36 occupations employing 28,068 females,* the chief causes claimed the following:

1. *Tuberculosis* .... 27 Occupations
2. *Cancer* .... 3 Occupations
3. Heart disease .... 5 Occupations
4. Apoplexy .... 1 Occupations

        Total .... 36 Occupations

A scrutiny of the type of occupations coming under each chief cause is very instructive:

1. *Tuberculosis*, "the captain of death" among occupied persons, was the leading cause of death in the following classified pursuits:

  (a) Agricultural:
      Laborers (M. and F.)†

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* The figures for two of these, stenographers and typewriters, and telegraph and telephone operators, have been obtained upon request from the Bureau of Census and added to those given in the tables.

† Males unless otherwise indicated. "M. and F." means these occupations for both Males and Females.

(b) Professional:
    Actors.
    Professional showmen, etc. (M. and F.)
    Architects, designers, draftsmen, etc.
    Artists and teachers of art.
    Electricians.
    Engineers (civil, etc.) and surveyors.
    Journalists.
    Musicians and teachers of music (M. and F.)
    Teachers and professors in colleges (M. and F.)

(c) Domestic and Personal Service:
    Barbers and hairdressers (M. and F.)
    Bartenders.
    Boarding and lodging house keepers.
    Housekeepers and stewards.
    Janitors and sextons (not specified) (M. and F.)
    Laborers (not specified) (M. and F.)
    Launderers and laundresses.
    Nurses.
    Restaurant keepers.
    Servants and waiters (M. and F.)
    Soldiers, sailors, and marines, U. S.
    Other domestic and personal service.
    Saloonkeepers.

(d) Trade and Transportation:
    Bookkeepers and accountants (M. and F.)
    Clerks and copyists (M. and F.)
    Commercial travelers.
    Draymen, hackmen, teamsters, etc.
    Hostlers.
    Hucksters and peddlers.
    Packers and shippers.
    Porters and helpers (in stores, etc.)
    Salesmen and saleswomen.
    Stenographers (M. and F.)
    Telegraph and telephone operators (M. and F.)
    Undertakers.
    Other pursuits in trade and transportation.

(e) Manufacturing and Mechanical Pursuits:
    Bakers.
    Bleaching and dyeing workers.
    Bookbinders (M. and F.)
    Boot and shoe makers and repairers (female.)
    Bottlers and soda water makers, etc.
    Box makers (paper.)
    Brass workers.
    Brewers and malsters.
    Broom and brush makers.
    Butchers.

(e)   Manufacturing and Mechanical Pursuits (*continued*) :
   Butter and cheese makers.
   Carpet factory operatives.
   Clock and watch makers and repairers of jewelry.
   Confectioners.
   Coopers.
   Cotton mill operatives (M. and F.)
   Distillers and rectifiers.
   Dress makers (female.)
   Engineers and firemen (not locomotive.)
   Engravers.
   Glass workers.
   Gold and silver workers.
   Hat and cap makers.
   Iron and steel workers.
   Leather curriers and tanners.
   Machinists.
   Manufacturing and mechanical pursuits (not specified) (female.)
   Marble and stone cutters.
   Masons (brick and stone.)
   Mechanics (not specified.)
   Milliners (female.)
   Model and pattern makers.
   Other food preparers.
   Other metal workers.
   Other textile mill operatives.
   Other textile workers.
   Other miscellaneous industries.
   Painters, glaziers and varnishers.
   Paperhangers.
   Photographers.
   Plasterers.
   Plumbers, gas, and steam fitters.
   Potters.
   Printers, lithographers and pressman (M. and F.)
   Roofers and slaters.
   Rubber factory operatives.
   Seamstresses.
   Shirt, collar and cuff makers (M. and F.)
   Silk mill operatives (M. and F.)
   Steam boiler makers.
   Stove, furnace and grate makers.
   Tailors and tailoresses.
   Tin plate and tinware makers.
   Tobacco and cigar factory operatives (M. and F.)
   Tool and cutlery makers.
   Trunks and leather case makers.
   Upholsterers.
   Wire workers.
   Woolen mill operatives (M. and F.)

Tuberculosis came second as the cause of death in the following:—
> Agents (M. and F.)
> Blacksmiths.
> Boatmen and sailors.
> Boot and shoe makers and repairers.
> Brick and tile makers, etc.
> Carpenters and joiners.
> Gardeners, florists, nursery men, etc.
> Hosiery and knitting mill operatives.
> Messengers, errand boys, etc.
> Miners and quarrymen.
> Officials of banks and companies.
> Oil well and oil works employes.
> Paper and pulp mill operatives.
> Saw and planing mill employes.
> Steam railway employes.
> Street railway employes.
> Telegraph and telephone linemen.
> Cabinet makers.

2. *Accidents* were the chief cause in the following occupations (all male) :
> Boatmen and sailors.
> Brick and tile makers.
> Charcoal, coke and lime burners.
> Dairymen.
> Fishermen and oyster men.
> Hosiery and knitting mill operatives.
> Lumbermen and raftsmen.
> Messengers, errand and office boys.
> Miners and quarrymen.
> Oil well and oil works employes.
> Other chemical workers.
> Paper and pulp mill operatives.
> Saw and planing mill employes.
> Steam railway employes.
> Street railway employes.
> Telegraph and telephone linemen.
> Wood choppers.

3. *Cancer* came first in three occupations (all female). Employed females in general have a high death rate from this cause, 8.1 per cent.
> 51 Agents.
> 54 Artists and teachers of art.
> 915 Nurses and midwives (cancer death rate—12.2%.)

The next three causes of death—heart disease, Bright's disease, and apoplexy—are essentially senile causes of death, and

hence not considered here as "preventable." However, when oc-
curring under 65 or 70 years, these diseases should be classed
largely as preventable. It is interesting to note the classes of oc-
cupied persons who succumb principally to these causes:

4. *Heart disease* polled a plurality in the following:

> Farmers, planters, overseers (M. and F.)
> Gardeners, florists, nursery men, etc.
> Stock raisers, herdsmen and drovers.
> Clergymen.
> Dentists.
> Lawyers.
> Physicians and surgeons (M. and F.)
> Literary and scientific perso s.
> Officials (government.)
> Other professional services.
> Foremen and overseers (manufacturers.)
> Watchmen, firemen and policemen, etc.
> Agents.
> Merchants and dealers (not wholesale) (M. and F.)
> Merchants and dealers (wholesale.)
> Manufacturers and officials, etc.
> Officials of banks and companies.
> Housekeepers and stewardesses (female.)
> Boarding and lodging house keepers (female.)
> Livery stable keepers.
> Blacksmiths.
> Boot and shoe makers and repairers (male.)
> Cabinet makers.
> Carpenters and joiners.
> Glove makers.
> Harness, saddle makers and repairers.
> Millers.

5. *Bright's disease* proved the chief cause of death in three
callings (all males) :

> Bankers and brokers.
> Hotel keepers.
> Wheelwrights.

6. *Apoplexy* in one small female group:

> Literary and scientific persons.

The Great Majority of Preventable Deaths Occur Under 45 Years of Age.

A glance at the following table suffices to show that the vast
majority of preventable death causes operate on the sunny side
of life.

Per Cent. of Preventable Causes of Death Which Occur Under 45 Years of Age.

Cause	Males Per cent.	Females Per cent.
Typhoid fever	80.0	90.1
Tuberculosis	69.7	87.0
Accidents	63.8	57.8
Accidental poisonings	56.7	74.8
Suicides	51.6	81.4
Occupational poisonings	43.2	50.0
Pneumonia	37.3	47.7
Cancer	13.9	29.4

REMARKS.—Omitting cancer, which occurs seven-eighths of the time after 45 years of age, we find that the other causes listed produce approximately 60% of the preventable deaths before 45 years of age in the case of males, and 75% in the case of females.

How the Working Classes Suffer From the Preventable Causes of Death.

(a) *Males:* Occupied persons may be divided into two classes, the proprietor and professional class, and the underling class. The proprietor and professional class (males) comprise thirty-one of the occupations and callings mentioned in the Census report. They are 59,926 in number and are composed of:

Farmers, planters and overseers	34,662
Retail dealers	9,329
15 professional callings	9,214
All others	6,721
Total	59,926

The balance of 6721 persons were employed in the following callings: Bankers and brokers, boarding and lodging house keepers, dairymen, foremen and overseers (manufacturing), gardeners, florists and nurserymen, hotel keepers, livery stable keepers, wholesale dealers, officials of banks and companies, restaurant keepers, saloon keepers, stock raisers, and undertakers.

Those engaged in 109 *working occupations,* a total of 147,674 persons (male) make up the balance of the occupations listed in our long table above. The preventable causes of death, as they occur among these two classes, are shown in the following table:

Cause of death	Per cent. P. & P. class	Per cent. working class
Tuberculosis	8.22	17.53
Accidents and injuries	5.20	11.85
Pneumonia	6.89	8.48
Suicide	2.13	2.76
Typhoid fever	1.88	2.35
Accidental poisoning	.43	.78
All preventable causes	24.75	43.75

Cancer, which is to be considered more or less a preventable cause of death, claims 6.99 per cent. of the deaths in the proprietor and professional class, as against 4.83 per cent. of all causes of death in the working class. This is because more of the former are found in the cancer age.

(b) *Females:* In the case of females, we have made no division between the two classes, but the pre-eminence of the preventable causes of death in the whole group speak for itself. The deaths among occupied females are grouped by pursuits as follows:

Agricultural pursuits	879
Professional	1.725
Domestic	17,735
Trade and Transportation	2,538
Manufacturing	4,582
Total	27,459

The chief causes of death among these were as follows: (Those in italics are the usually accepted preventable causes of death.)

	Per cent.
Pulmonary tuberculosis	21.0
Heart disease...	10.3
(*Cancer*)	8.1
Bright's disease	7.3
Pneumonia	7.0
Apoplexy, etc.	5.9
Digestive diseases	3.6
Accidents, etc.	3.2
Circulatory diseases	3.0
Childbirth	2.9
Typhoid	2.8
Nervous diseases	2.6
Suicide	1.6
Appendicitis	1.3
Diabetes	1.0
Bronchial, liver, rheumatic affections, etc., each under 1%, Total	5.7
All other unknown causes	12.8
Total	100

These are conservative estimates, since many other causes of death than those particularly specified were preventable in many individual cases. Probably a fair estimate would be that 50 per cent. of all deaths among occupied persons are due to preventable causes. This would mean that over 120,000 workers in 140 occupations were needlessly sacrificed in the year 1909, in the registration area alone, which includes 56.1 per cent. of the total population of the country. Hence something over 225,000 persons, or approximately a quarter of a million, would be more nearly the correct figure.

THOSE WHO SUCCUMBED TO THE MORE NATURAL CAUSES OF DEATH.

Accepting the calling of "farmers, planters, and farm overseers" as the one which is freest of all untoward occupational influences it is of value to note that the four chief causes of death among 34,662 such persons are found to be: heart disease (16.1 per cent.), apoplexy (11.3 per cent.), Bright's disease (8.2 per cent.) and cancer (7.2 per cent.). These same causes of death occur in the following callings, in almost the same order, although in some instances, circulatory causes juggle with cancer for fourth place: Clergymen, lawyers, physicians and surgeons, bankers and brokers, wholesale dealers, manufacturers and officials in general.

Obviously, *it is due to the great preponderance of the preventable causes of death*—tuberculosis, pneumonia, accidents, etc., *that these four chief senile causes of death* mentioned in the preceding paragraph *do not obtain in the working classes.*

The following two tables* are also from the same Census statistics, but are arranged to show the proportionate toll of tuberculosis in American occupations in the Death Registration Area.

* Compiled from Tables VIII and IX, and Tables 11 and 12, "Occupation Mortality Statistics," 1909, U. S. Bureau of Census. The figures for stenographers and typewriters, and telegraph and telephone operators, female, which do not appear in "Mortality Statistics" as published, have been obtained upon request from the Bureau of Census. Readers should note that the discussion herein concerns the percentage or proportion which *consumption* played as a cause of death in the total causes of death, and that this is not a "death rate" of the respective occupations since the numbers so employed are not given.

PROPORTION OF TOTAL DEATHS DUE TO TUBERCULOSIS.

Occupied persons	Total deaths reported	Deaths from pulmonary tuberculosis	
		Number	Per cent.
Males	210,507	31,059	14.8
Females	27,459	5,764	21.0
Total	237,966	36,823	15.4

ACCORDING TO OCCUPATION.

Per cent. of deaths of all deaths from pulmonary tuberculosis.	Occupations*	Ascending numerical order.
10.4	Agents	21
8.7	Agricultural pursuits combined	13
8.6	Agricultural pursuits combined (female)	10
18.6	Bakers	44
5.9	Bankers and brokers	1
23.9	Barbers and hairdressers	66
27.9	Bartenders	75
11.4	Blacksmiths	25
19.6	Boilermakers (steam)	52
22.5	Bookkeepers and accountants	62
35.7	Bookkeepers and accountants (female)	90
13.4	Boot and shoemakers and repairers	28
31.8	Boot and shoe operatives (female)	87
31.3	Brass workers	86
12.0	Brick and tile makers	26
16.2	Butchers	37
10.9	Cabinet makers	23
10.1	Carpenters and joiners	20
6.6	Clergymen	4
28.3	Clerks and copyists	78
31.9	Clerks and copyists (female)	88
20.1	Clock and watch makers and repairers	55
13.7	Coopers	29
21.1	Cotton mill operatives	58
9.3	Dentists	17
18.6	Domestic and personal service (female)	43
19.2	Dressmakers (female)	50
24.1	Electricians	69
12.6	Engineers and firemen (not locomotive)	27
6.6	Farmers, planters and overseers	5
7.9	Farmers, planters and oversers (female)	9
8.7	Foremen and overseers (manufacturing)	14
31.1	Glassworkers	85
20.6	Hostlers	56
9.3	Hotel keepers	16
18.3	Hucksters and peddlers	41
16.3	Iron and steel workers	38
13.9	Janitors and sextons	30
19.9	Laborers (not specified)	54
26.5	Launderers	72

* Males unless otherwise indicated. The least number of total deaths recorded in any occupation here listed is 118.

Per cent. of deaths of all deaths from pulmonary tuberculosis.	Occupations	Ascending numerical order.
18.5	Laundresses	42
7.5	Lawyers	8
18.3	Machinists	40
6.3	Manufacturers and officials, etc.	2
28.6	Marble and stone cutters	80
13.9	Masons (brick and stone)	31
15.5	Mechanical and manufacturing pursuits	34
27.4	Mechanical and manufacturing pursuits (female) .	73
9.9	Merchants and dealers (not wholesale)	18
7.0	Millers	7
20.6	Milliners (female)	57
8.8	Miners and quarrymen	15
23.4	Musicians and teachers of music	63
11.1	Nurses and midwives	24
8.6	Officials (government)	11
29.2	Packers and shippers	82
18.9	Painters, glaziers and varnishers	46
23.9	Paper hangers	65
6.6	Physicians and surgeons	3
17.6	Plasterers	39
29.2	Plumbers, gas and steam fitters	81
28.3	Porters and helpers in stores	79
34.6	Potters	89
29.2	Printers, lithographers and pressmen	83
19.0	Roofers and slaters	49
27.9	Rubber factory operatives	76
10.4	Sailors and boatmen	22
15.8	Salesmen (in stores)	36
31.1	Saleswomen (in stores)	84
15.5	Saloonkeepers (proprietors)	35
24.2	Seamstresses	70
7.0	Steam railway employes	6
37.0	Stenographers and typewriters	91
38.8	Stenographers and typewriters (female)	92
18.9	Street railway employes	45
19.0	Tailors	48
24.0	Tailoresses	68
15.2	Tanners and leather curriers	33
15.0	Teachers, college professors, etc.	32
21.5	Teachers, college professors, etc. (female)	59
23.4	Teamsters, etc.	64
28.1	Telegraph and telephone operators	77
43.0	Telegraph and telephone operators (female)	94
18.9	Tin plate and tinware makers	47
24.3	Tobacco and cigar factory operatives	71
40.5	Tobacco and cigar factory operatives (female) ..	93
24.0	Tool and cutlery makers	67
10.0	Travelers (commercial)	19
19.8	Upholsterers	53
21.7	U. S. soldiers and sailors	60
27.6	Waiters and servants	74
19.5	Waitresses and servants (female)	51
8.7	Watchmen, policemen, firemen, etc.	12
22.2	Woolen mill operatives	61

Beginning with the low tuberculosis death rate among bankers and brokers, 5.9 per cent. (1), the per cent. increases with occupation; the first 31 callings in numerical order is below *the general average,* 14.8 *per cent., for all occupied males,* but still most of them are above the rate for farmers, planters and overseers.

It is surprising to note that certain trades and callings are listed as below or above the general average, but this is because (1) tuberculosis has strong competitors in certain avocations; for instance, 53.4 per cent. of deaths among steam railway employes were the result of accidents and injuries, 38 per cent. of miners and quarrymen, from like causes, and as Dr. Wm. Ogle said, "A man who is killed by an accident cannot also die from phthisis or any other disease;" (2) it is also apparent that there are 12 callings listed in which the proportionate tuberculosis death rate is even less than it is among male agriculturalists as a group, who rank 13th, but *some of these pursuits are not entered upon until later in life when tuberculosis is a less common cause of death;* (3) many of the trades are carried on *in the most tuberculous age group* (20 to 35); and (4) in a number of these trades the occupation was purely incidental, *i.e.,* many of the workers were tuberculous when they began the occupation, and delicacy of constitution prevented them from choosing other vocations.

In quite analogous industries there may be great differences in rates, depending upon peculiar industrial factors. Compare iron and steel workers with brass workers; saloon proprietors with bartenders; coal miners and quarrymen with stone cutters.

The relationship between different callings and a given disease, such as *tuberculosis,* can be fairly satisfactorily determined. The following table furnishes an example. Compare the first column with the second column, and note that housing, habits, dietetics, etc., cut no figure, at least with the first four comparisons:

TUBERCULOSIS DEATH RATE.

	Per cent.		Per cent.
Quarrymen and miners ..	9.0	Stonecutters (indoor work)	29.
Carpenters	10.	Painters	31.
Iron and steel workers ..	16.	Brassworkers	31.
Domestics	19.	Stenographers	39.
Farmers, planters and overseers	6.6	95 out of 100 callings 8.0 to	43.

Following is a list of the deaths from pulmonary tuberculosis in various occupations, per 100,000 inhabitants compiled by the Chicago Tuberculosis Institute:[57]

1. Marble and stonecutters 541
2. Cigarmakers, tobacco workers 477
3. Plasterers, whitewashers 453
4. Compositors, printers, pressmen 436
5. Servants 430
6. Hat and cap makers 415
7. Bookkeepers, clerks 398
8. Laborers (not agricultural) 371
9. Tinners and tinware makers 365
10. Cabinet makers and upholsterers 359
11. Musicians and teachers of music 350
12. Glassblowers and glassworkers 342
13. Barbers and hairdressers 335
14. Sailors, pilots, fishermen 333
15. Painters, glaziers, varnishers 319
16. Leathermakers 311
17. Apothecaries, pharmacists 306
18. Coopers 300
19 Plumbers, gas and steamfitters 294
20 Masons 294
21. Butchers 288
22. Saloon and restaurant keepers, bartenders and liquor dealers 286
23. Liverymen and hostlers 268
24. Teamsters, hackmen 261
25. Boatmen, canalmen 257
26. Janitors, sextons 251
27. Hucksters, peddlers 251
28. Bakers and confectioners 250
29. Iron and steel workers 236
30. Carpenters and joiners 231
31. Engineers and firemen 230
32. Leather workers 227
33. Tailors 218
34. Blacksmiths 213
35. Hotel and boardinghouse keepers 210
36. Textile operatives 208
37. Machinists 196
38. Architects, artists 189
39. Gardners, florists, etc. 187
40. Physicians and surgeons 169
41. Merchants and dealers 164
42. Engineers and surveyors 145
43. Teachers 144
44. Lawyers 140
45. Policemen, watchmen, detectives 137
46. Boot and shoe makers 136

Deaths from pulmonary tuberculosis (*continued*).

Among the most important causes of death among occupied males are the following five: Pulmonary tuberculosis, accidents, pneumonia (lobar and broncho), Bright's disease and organic heart disease. Dublin's Tables[58] cover 19 occupations, all told, of which I have selected the 6 shown in Table (p. 165) herewith, including "farmers" for comparison. Only the four age periods representing middle life are given on following page.

Considering *all occupations combined,* (a) *tuberculosis* of the lungs is the most prevalent cause of death, (being responsible for 20.5 per cent of all deaths at all age groups). Its maximum age group is 25 to 34 years when it causes 40.9 per cent of all deaths. Dublin states, however, that on the basis of exposure the highest rate from tuberculosis is in the age period 35 to 44 years, which does not appear in the figures because depressed by the increase in mortality from other causes. Of Dublin's 19 occupations, tuberculosis of the lungs was the most frequent cause of death in 15. The proportionate mortality was *highest* among clerks, bookkeepers, and office assistants (35 per cent.); *high* among compositors and printers, plumbers, gasfitters, and steam fitters, longshoremen and stevedores; and teamsters, drivers, and chauffers; and *least* among coal miners (5.8 per cent.). Also low among farmers and farm laborers (9.7 per cent.). (b) *accidents* showed the highest proportion in the very earliest age group (15 to 24 years) when 19.2 per cent. of all deaths were from these causes. If, in this period, all external causes, excepting homicide, are combined, the total percentage is 22. Next to tuberculosis of the lungs, this group of causes is most important. The *highest* proportion occurs among railway enginemen and trainmen (42.4 per cent.); it is *high* among railway track and yard workers and among coal miners; and *least* among saloon keepers and bartenders. (c) *Pneumonia* increases by age periods to the maximum, 8.2 per cent., at the age period 45 to 54 years. It is *highest,* apparently, in occupations exposed to alcohol and to

INDUSTRIAL MORTALITY FROM FIVE PRINCIPAL CAUSES, 1911-1913, EX-
PRESSED IN PERCENTAGES OF ALL DEATHS FOR EACH AGE PERIOD.
(Metropolitan Life Insurance Company).

	Age groups	Pulmonary tuberculosis	Accidents	Pneumonia	Bright's disease	Organic heart disease
All occupations	25—34	40.9	12.5	7.3	4.5	5.4
	35—44	32.9	9.9	8.1	7.8	7.7
	45—54	18.5	8.5	8.2	11.1	11.1
	55—64	8.6	6.5	7.5	13.3	15.9
Blacksmiths ..	25—34	28.7	12.6	13.8	6.9	8.0
	35—44	35.8	5.5	7.3	6.7	5.5
	45—54	17.0	4.2	7.2	11.1	11.5
	55—64	8.3	5.0	7.1	12.5	15.1
Farmers and farm laborers	25—34	31.8	16.2	6.6	5.1	3.5
	35—44	30.5	11.3	7.1	3.0	6.8
	45—54	13.9	9.0	7.7	10.2	13.7
	55—64	6.7	8.0	5.9	9.0	18.5
Laborers	25—34	34.8	11.7	10.3	5.4	6.7
	35—44	33.9	10.6	9.7	6.8	7.1
	45—54	20.1	9.2	9.5	10.2	11.8
	55—64	8.1	6.5	9.8	11.9	15.7
Railway engine-men and train-men	25—34	14.7	57.7	4.7	2.0	1.3
	35—44	24.9	30.0	6.9	7.5	5.2
	45—54	13.8	18.3	9.2	9.2	10.1
	55—64	7.4	17.1	6.4	10.6	13.8
Railway track and yard workers	25—34	27.2	34.6	4.9	2.9	3.7
	35—44	21.1	32.3	6.5	6.0	6.9
	45—54	10.2	19.5	6.0	10.8	9.9
	55—64	5.1	13.0	7.4	11.4	13.7
Teamsters, dri-vers, and chauffers ...	25—34	42.7	9.8	10.5	4.6	5.9
	35—44	35.7	10.4	8.6	7.9	7.3
	45—54	20.2	10.7	9.5	11.6	9.9
	55—64	10.0	7.8	6.8	11.7	15.9

those in which sudden changes in temperature occur: Iron
molders (10.6 per cent.) ; coal miners; laborers; saloon keepers
and bartenders; teamsters, drivers and chauffers; and longshore-
men and stevedores. It is lowest among cigarmakers and tobacco
workers; compositors and printers, and railway enginemen and
trainmen. (d) *Bright's disease* is a prominent cause of death at
all age periods (9.6 per cent.), but especially after 35 years of
age, when there is a steady increase by age periods. It shares with
cirrhosis of the liver and alcoholism the characteristic of being

most prevalent among saloon keepers and bartenders and *very low* among railway enginemen and trainmen. It is *high* also among painters, paper hangers and varnishers. (e) *Organic heart diseases* is next to tuberculosis in numerical importance (12.0 per cent. of all deaths in all occupations combined). It shows its highest proportion at the advanced ages. It is the leading cause of death in age periods beginning with 55 to 64 years, and after. It is *highest* among farmers and farm laborers (16.5 per cent. of all deaths), laborers and blacksmiths; *least* among railway enginemen and trainmen. Dublin points out, however, that this as a cause of death, is often obscure, and hence cautions against inferences too hastily drawn.

"To summarize the above discussion, we find in the age period 15 to 24, two causes of preëminent importance, namely, tuberculosis of the lungs and accidental violence. Together they are responsible for 53.0 per cent of all deaths. In the age period 25 to 34 pneumonia becomes significant, and, added to the two aforementioned causes, increases the proportion to 60.7 per cent. of the total. In the age period 35 to 44, Bright's disease and organic diseases of the heart raise the number of principal causes to five which together form 66.4 per cent. of all of the deaths. There is no striking change in conditions in the two succeeding age periods. In the age period 55 and over, organic diseases of the heart lead, and, together with Bright's disease, cerebral hemorrhage, apoplexy, and paralysis, cancer, and pneumonia, give a total of 61.1 per cent. of the deaths from all causes."

The U. S. Bureau of Labor Statistics, in its Monthly Review for January, 1917 (pp. 84 to 89), gives a table showing "death rates, average age at death and per cent. of total deaths due to specified causes among members of benefit funds of certain labor organizations." Analyses of these tables, which were made for twenty-four trade organizations, show as follows:

Pulmonary tuberculosis was by far the leading cause of death among journeymen, barbers, boot and shoe workers, cigar makers, glass bottle blowers, hatters, painters, decorators and paper hangers, printers, printing pressmen, stone workers, journeymen tailors, railroad telegraphers, and woodworkers. It was also the chief cause of death among carpenters and joiners, stationary engineers, iron molders, street and electric railway employes, and sheet metal workers.

Accidents were by all odds the chief causes of death among steam railway conductors, electrical workers, locomotive engineers, foremen and

enginemen, lake seamen, and particularly switchmen and railroad trainmen, Accidents were also relatively high among carpenters and joiners, painters, decorators and paper hangers, street and electrical railroad employes, sheet metal workers and railroad telegraphers.

Pneumonia was unduly frequent among iron molders and rather frequent among journeymen barbers, boot and shoe workers, carpenters and joiners, hatters, painters, decorators and paper hangers, printers, printing pressmen, street and electric railway employes, sheet metal workers and woodworkers.

Bright's disease was frequent among painters, decorators and paper hangers, printing pressmen, and street and electric railway employes, and only slightly less so among carpenters and joiners, and journeymen tailors.

Heart disease was frequent among boot and shoe workers, glass bottle blowers and above the average in carpenters and joiners.

Apoplexy had a relatively high rate among steam railroad conductors, stationary engineers, locomotive engineers, printers and journeymen tailors.

The *suicide* rate was highest among cigar makers, journeymen tailors, telegraphers and wood workers.

Cancer and Occupation.

Hoffman[59] says the English data are the most trustworthy and conclusive available for the present purpose, and particularly the standarized death rate. We excerpt from Hoffman's work as follows the (English and Welch) standardized death rate, males, from cancer per 100,000 population, aged 15 and over in selected occupations:

Chimney sweeps	225	Carpenters and joiners	98
Seamen	171	Tobacconists	95
Brewers	167	Farmers and grazers	95
Tailors	113	Domestic indoor servants	93
Textile workers	113	Printers	93
Fishermen	112	Quarrymen	91
Lawyers	112	Potters	91
Inn-keepers	109	School teachers	90
Gas-works service	107	Iron-mongers	87
Corn-millers	105	Coal merchants	76
Shoe makers	103	Gardeners and nurserymen	85
Butchers	103	Railroad engine drivers and	
Malsters	102	stokers	85
Physicians	101	Coal miners	82
Metal workers	101	Farm laborers	80
Hatters	101	Tanners	78
Glass-workers	101	Grocers	77
Bakers	99		

Death rates per 100,000 for "all males" from cancer at different age-groups were as follows:

```
35 to 44 years of age ............................... 39.9
45 to 54   "    "    "   ............................... 144.7
55 to 64   "    "    "   ............................... 362.2
65 years and over ................................... 638.3
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Increases in cancer death rate were noted for all occupations above listed, as compared to the same groups 10 years previously, with the exception of chimney sweeps, quarrymen, malsters and gas-works service. The increases were, from 1 per 100,000 in coal-merchants to 37 per 100,000 in textile-workers.

INFLUENZA AND OCCUPATION.

Soft coal miners showed a high rate of mortality due to *influenza-pneumonia* in the epidemic of 1918. Thus Starr[60] estimated the rate among Ohio coal miners to be 826.5 as against 635 per 100,000 males 15 years of age and over in the State at large. The age period distribution was as follows:

Age periods	Per cent. of influenza pneumonia deaths.
15 to 24	17
25 to 34	37
35 to 44	28
45 and over	17 +
	100

CONTROL AND PREVENTION—GENERAL PRINCIPLES.

Principle I. If it is hazardous to human lives to produce an article of human usefulness, then the cost of production should include the cost of the conservation of health.

Principle II. A proper place to work, and safe methods of working, and some knowledge of the dangers to health and life are pre-requisites to conducting any business, or to working, no matter whether one man or a thousand are concerned, and whether the individual is an employer or an employe.

Principle III. The health of the individual is an affair of the State, since his dependency, wilful or otherwise, becomes a burden upon the State, directly or indirectly.

1. From what has been said above regarding ill-health due to occupation, it would appear that, for the employe, the most feasible solution is to pay more attention to the *trivial health complaints* as they are encountered in everyday work life, rather than wait

for definite occupational disease or any diseases to appear. It can very often be shown that such complaints as headache, coughing, dyspepsia, pains, sleeplessness, constipation, etc., bear a definite relation to some one or more of the health-hazards above discussed.

2. The day of universal *physical examinations* for employment fitness is close at hand. A number of states have made it compulsory for the employment of minors as they leave school to enter industry. A number of establishments now require it for all employes. It should be made periodic. Its objective should not be to select and discard but to select and fit. Its findings should be handled with great elasticity so that occupational therapy may prove to find a definite place during invalidity and especially convalescence.

Insurance experience on the results of periodic physical examinations is truly astounding in the matter of extending longevity. Dr. A. S. Knight, President of the Life Insurance Medical Directors (1921) has reported the first exhaustive analysis of the results of periodic physical examinations in reducing mortality :[61]

Examinations of a group of 5987 males were begun by the Life Extension Institute, New York City, in 1914. Subsequent examinations were had for later dates, and the mortality of the group studied up to Nov. 15, 1920. The results have shown, at practically every age period, a much lower death rate (53 per cent. of the American Experience Table and 72 per cent. of the American Men Table ultimate). The Metropolitan Company found there had actually been but 217 deaths in this group, in the elapsed time stated, as against an expected number of 412. The cost of all the physical examinations was approximately $40.000. The value of the mortality gains was $126,677. The net gain therefore is $86,000, from which home office expenses of $8,900 should be dedu ted, leaving a net profit of $77,100.

3. As a people we are afflicted with the evils of civilization. The best cure for civilization is more civilization. This means that in order to prevent wastage and interference there must be a constant drawing up of codes of procedure, regulations, laws, etc., and a constant evolution of them. These become more necessary as population, congestion and stress increase. Note the example of the city traffic codes. If holocausts, such as the Iroquois, Triangle, and General Slocum fires, and the Eastland disaster may take place suddenly because of the lack of *specific regulations* and

their observation, one may only conjecture what the situation is in the field of the more slowly progressive industrial hazards, such as fatigue, ventilation, illumination, etc. What, then, is wanted is more specificity, more down in black and white, which has been placed there after careful thought and which is available for constant reference for modes of procedure.

4. Excellent methods of attack are gradually being developed in various states. The impracticability of statutory regulations has at last become obvious. We see legislatures now delegating the authority for framing specific rules and regulations for the conduct of particular industries to an Industrial Board or Commission. This corresponds exactly to the method of "administrative orders," which is characteristic of European countries. These Commissions, in turn solve the various problems of sanitation, ventilation and industrial hygiene by *"get-together committees"* of employers, employes, and experts who draft specific rules and regulations for their respective industries. As guides, the committees have but to turn to the many rules and regulations which have been published abroad. Very often foreign past experiences are our present ones. The New York Industrial Commission, noting this, began by publishing a special bulletin entitled "European Regulations for the Prevention of Occupational Diseases" (Bulletin No. 76, issued March, 1916, Albany, N. Y.). Furthermore, we now have such publications as the New York "Labor Code" which may be taken as a guide.

5. *Compensation* for occupational disease on the same basis as for accidents is regarded as a step in the right direction but the controversial nature of the individual case is often a serious block; also, since acute manifestations of occupational diseases are usually over within a few days, compensation allowed after a waiting period of a week or two, as is usually the case, accrues to but a small percentage of those afflicted. This is more so if sequelæ are not covered, as in the Ohio law. The occupational disease, as stated by Collis, is but the guide-post to a larger field, industrial medicine, and a broader coverance must be the ultimate solution. The extension of sickness or disability compensation so as to include all kinds and stages of sickness on an insurance basis (group insurance of the private companies, the mutual aids, or sickness insurance of foreign countries) is

undoubtedly approaching toward the solution for ultimate relief. Such will also greatly stimulate preventive measures.

6. Many *intensive investigations* must yet be made, using as a guide any and all of industrial health complaints. Hence, statistics collected by the industries themselves, and particularly the observations of the industrial physician, become of paramount importance. But he must skill himself in the science of industrial hygiene. Experience shows that industry's doors are open to him, welcoming his help.

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Diseases of the Heart

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Diseases of the Heart.

THE IMPORTANCE OF HEART DISEASE.

TODAY heart disease heads the list of the causes of death. Whereas the death rate from tuberculosis has declined, that of heart disease has increased. The table drawn from the mortality statistics in Philadelphia and the facts set forth in the chapter on Heart Disease as a Public Problem, on page 377 of this article, emphasize the importance of this complaint. Again the discovery of the auriculo-ventricular connecting system and the introduction of the electrocardiograph and polygraph gave a new interest to the study of heart disease. This reawakened interest in cardiac disease found a large number of medical men prepared to seize upon the lessons to be learned from the examination of thousands of recruits assembled during the world war. The realization that infections are commonly the basis of early heart disease and that its beginning is often laid in early childhood dawned upon the profession. The importance of foci of infections now receives general acceptance. The trend in the profession today is not to rest content with treating the terminal stages, but also to bend its energies to the prevention of heart disease. Statistics, though still meager, point to the fact that acute rheumatic fever is less common in the hospitals today than it was formerly.[1] This may be one of the first fruits of the more common removal of adenoids and tonsils. Again the good effects of prolonged after-cure combined with suitable exercises open up a new chapter in the treatment of heart disease. The number of working days that may be added to the cardiac, who has repeated medical examination and advice, is of no small economic importance.

For the space given to the myocardium and especially to its motor disturbances no apology is needed today. Heretofore valvular diseases have been discussed at length, whereas the more important myocardium has but recently received

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the attention it warrants. An inefficient valve, broadly speaking, is of little importance as compared with an inefficient myocardium. In a certain percentage of patients precise methods portray, often dramatically, the functional changes present in the diseased myocardium and afford an understanding of the underlying causes of the symptomatology and signs found at the bedside. But the heart station, like the laboratory, should be expected to help and not supplant the trained eye, ear and finger of the diagnostician.

To recapitulate, the importance of heart disease today is found in its frequency, in the new methods of investigating the heart and the action of drugs upon it, in a better understanding of the causes of heart disease, which opens up the question of the prevention of this complaint. With respect to prevention, there is great activity all over the country and it is not too much to expect that the good results will be comparable to those obtained in the campaigns against tuberculosis.

CAUSES OF HEART DISEASE.

The commonest cause of heart disease, by all odds, is infection, which may be immediate or remote. The foundations of heart disease, especially of myocardial change, becoming evident in middle life, are often laid in youth. Most infectious diseases are potential causes and among these rheumatic fever holds the first place. We are still ignorant of the exact infective agent causing acute rheumatic fever. There is no gross pathologic change pathognomonic of this disease, for even the submiliary nodules demonstrated by Aschoff in the heart muscle and considered histologically characteristic of acute rheumatic disease, undergo fibroid change in chronic cases and lose their intrinsic features. In spite of our lack of sufficient knowledge of the pathology of acute articular rheumatism, clinically the close relationship between this complaint and heart disease is well established, both in children and in adults. It is not only a common cause of endocarditis, valvulitis and pericarditis, but tends to involve the myocardium as well, especially in childhood, so that at this period of life, pancarditis well expresses

the conditions found. The close connection between chorea and acute rheumatic fever is admitted, and the relationship between chorea and cardiac involvement is a well recognized one. Syphilis is a common underlying cause of heart disease becoming evident in middle life; syphilitic involvement of the proximal portion of the aorta and the aortic valves is well known; the vessels of the heart itself do not escape the degenerations due to this process, which in turn leads to myocardial degeneration. Fibrotic changes in pericardium, endocardium and valves, are often due to this infection.

In diphtheria, fatty degeneration of the heart is a common finding. Often there are more advanced degenerations which may lead to fibrous myocarditis. Endocarditis and pericarditis are comparatively rare.

A recent clinical and electrocardiographic study of the effects of the diphtheritic toxin upon the heart was made by Dr. S. Calvin Smith[2] in two hundred and forty-two patients in the Philadelphia Hospital for Contagious Diseases. He divides the motor irregularities of the heart into the initial tachycardia and the irregularities of convalescence. The initial tachycardia usually subsides in forty-eight hours after the administration of antitoxin. It is of serious importance only when it is persistent. It may then be a precursor of heart block. The other heart irregularities arose between the sixth and eighth days of the disease and occurred in twenty-eight per cent. of the series. Of these sixty-five per cent. were sinus arrhythmia and sino-auricular block, twenty per cent. were premature contractions, of which the auricular form was five times as common as the ventricular. There was no circulatory embarrassment in any of the irregularities already mentioned. The other fifteen per cent. developed high grade heart block, sudden in onset and accompanied with rapid cardiovascular failure. None of these patients survived. Some of the curves in this article suggest that not only was auriculo-ventricular block present but also branch bundle block. Dr. Smith's studies reaffirm the need for the early use of antitoxin in diphtheria, and prolonged rest during convalescence.

The frequency of pericarditis in pneumonia is discussed under the heading of pericarditis. Endocarditis, either the

so-called simple or the ulcerative form, may be found in pneumonia; it is commoner on the left side of the heart than on the right; in protracted cases of pneumonia with intrathoracic suppuration, even when the heart membranes are not directly involved, myocarditis, especially in the form of early fatty degeneration, may be found.

In typhoid fever, endocarditis and pericarditis are not common, but they do occur. Though the bacillus and its toxins appear to have a less harmful effect upon the heart than many other infections, their prolonged action and the long febrile period are often followed by cardiac insufficiency which may be prolonged and from which some hearts never recover. Naturally, the hearts showing abnormality in the beginning are most gravely affected. The added load imposed upon a sufficiently hypertrophied ventricular muscle to meet the demand before typhoid fever is too much for it under the new conditions.

In scarlet fever, cardiac complications are common; an endocarditis may be present, varying from the simple form to the malignant. Purulent pericarditis is not an uncommon finding. In severe cases occasionally a sudden dilatation, due to acute myocarditis, may arise. In these severe cases, the attention may be focused elsewhere and the insidious onset of cardiac complications pass unnoticed.

Puerperal fever, and septic processes in general, are frequent precursors of both endocarditis and pericarditis.

Gonorrhea is probably a commoner cause of acute endocarditis and pericarditis than is generally recognized. Many cases are reported in the literature.

· It is only in recent years that the subject of focal infections has received the attention that its importance warrants. (Billings's stimulating paper appeared in 1912.[3]) The close connection between rheumatic fever and tonsillitis at times, also between tonsillitis and endocarditis, has been recognized clinically, but it was not recognized for a long time that unless the whole tonsil, with its capsule, was removed, foci of infection might remain in the tonsillar tissue, the peritonsillar tissue, and in the supratonsillar fossæ. The large amount of lymphoid tissue, especially in the throat of a child, offers an explanation of the frequency of infections like rheu-

matic fever and diphtheria in these patients. When this lymphoid tissue is diseased, as in adenoids, the danger of systemic disease arising from these sites is all the more likely.

That pyorrhea alveolaris, gum abscesses, and abscesses about the roots of the teeth, might be sites of infection leading to systemic disease, was but little appreciated years ago. The great numbers of patients in any large municipal hospital, who had bad teeth and pyorrhea and yet did not suffer from joint troubles, made many medical men look askance at those who dwelt upon the dangers of such infective areas. They overlooked the fact that the kinds of microörganisms in these sites varied, that their virulency was not the same, and furthermore, that systemic infection led to endocarditis and nephritis as well as to polyarthritis.

The pneumococcus is common in the upper respiratory passages in health. What changes it into the virulent type we can not tell. Unquestionably, the resistance of the patient at a given time must play a rôle. Not all the world war recruits with the meningococcus in the nasal discharge developed epidemic cerebrospinal meningitis.

The point is that we can not tell which of the carriers of these two organisms will develop the systemic disease and our power to prevent it is but little. On the other hand, the foci of infection in tonsils, teeth, gums and sinuses can be eradicated. Not only is there danger of invasion by the microbes at any time, especially when the patient's health is depressed, but their relation to perverted digestion by being swallowed has been demonstrated, also the deleterious influence of the constant absorption of the toxins elaborated in these foci is undesirable.

Chronic inflammation of the sinuses in the head, the maxillary, ethmoidal, frontal and sphenoidal, may lead to systemic infections, including the heart. Chronic cholecystitis and chronic appendicitis are among the possible foci. In the genitourinary tract, the prostate and the seminal vesicles, the bladder and the pelvis of the kidney are important foci. Infections from the uterus and Fallopian tubes and the parametrium are all possible foci. Lung cavities and dilated bronchial tubes are also possible sources of infection. It is remarkable how some of the chronic middle ear cases run

so long without evidence of systemic infection other than general ill health. Erysipelas may be a precursor of general infection. Even boils and carbuncles are possible sources of infection. Though I have not traced a direct connection between a carbuncle and heart disease, I have seen acute nephritis follow in the wake of this infection and persist for years.

Of the metabolic diseases, gout is commonly associated with cardiovascular disturbances. Arteriosclerosis, chronic interstitial nephritis, high blood-pressure, and finally, hypertrophy of the left ventricle, are common sequences. Pericarditis is common in terminal cases.

Of the endocrine disturbances in which the heart is affected, the commonest is hyperthyroidism. The simple tachycardia in this disease is one of the most common symptoms. In the beginning, the apex rate may vary from ninety to one hundred; later in the disease, it may rise to one hundred and thirty, and occasionally as high as one hundred and sixty. Irregularity due to premature beats has not been uncommon in some cases, even with pulse rates of from one hundred and twenty to one hundred and thirty. Fibrillation in this condition is a late phenomenon. The area of cardiac dullness and pulsation is increased; the peripheral arteries pulsate visibly. Endocardial murmurs are common in this complaint, and the heart sounds may be very loud. Occasionally, attacks of acute dilatation may occur. The poisonous substance is thyroxin, which Kendall demonstrated to be a normal constituent of the thyroid gland. In hyperthyroidism it is in excess in the system and its action on the myocardium, as well as on other tissues, is that of a cellular poison.

In arteriosclerosis, the heart is not sound. The vessels of the heart are apt to be involved, just as the vessels elsewhere. Many of these patients have angina pectoris and a myocardium too weak for the daily demands made upon it. The myocardium may be affected not only by arteriosclerotic vessels but also by infections. The latter may set up a genuine silent but progressive myocarditis. It may become evident only when it involves some part of the *A-V* connecting system. This has been recognized for some time. More recently, it has been realized that the subendocardial

Purkinje system and adjacent myocardium are affected both by arterial degeneration and by infections. The latter may be readily carried by the intrinsic blood supply of the heart. Evidence of this is found in the impaired conduction in the distal portions of the *A-V* connecting system.

In arteriosclerosis and kidney disease with hypertension, the heart must hypertrophy to meet the increased demands upon it. This leads to enlargement and though it may be functionally perfect for a time, no heart showing definite enlargement is an entirely normal heart.

The frequent association in the same patient of heart disease and fibroid tumors of the uterus led to a belief for a time that the latter was provocative of the former. McGlinn,[4] from a careful clinical and post mortem study of the subject, arrived at practically the following conclusions: That uterine myomas occurring in middle and advanced life are practically always associated with sclerotic heart lesions. These lesions are part of a general process and bear no relation to the fibroid. Large tumors, by increasing the work of the heart, also tumors causing pressure on the pelvic circulation, may produce hypertrophy and secondary dilatation of the heart. Anemia from hemorrhages, infections and certain degenerations of the tumor, may affect the heart secondarily, causing the fatty degeneration, brown atrophy, and cloudy swelling dwelt upon by the early observers in studying this relationship. There is no reason for suspecting that these degenerations are caused directly by the fibroid tumor.

PERICARDITIS.

Pericarditis was recognized in ancient medical writings, especially in the form of a "hairy heart," but the possibility of its clinical diagnosis dates only from 1824, when Collin pointed out the characteristic to-and-fro rub in the acute form. Even today it is more frequently found at post mortem than at the bedside, for on the one hand it may exist with few clinical signs, and on the other, it is so often a complication of other grave diseases that its existence is overlooked. Traumatic pericarditis belongs in surgical practice. This form of pericarditis is usually due not so much to traumatism as

to infectious agents introduced by the injury. Foreign bodies from the esophagus and stomach may cause perforation and inflammation of the pericardial sac, which usually terminates in the purulent form; false teeth were responsible in a patient of the elder Flint. This form, due to foreign bodies, is common in the domestic animals.

The first post mortem I ever saw was done by an old lady upon a prize fowl whose indisposition had failed to respond to her sovereign remedy, asafetida; the offending body was a broken needle attached to a goodly length of thread; the gullet was perforated and many of the viscera were encased in inflammatory exudate. Recently a friend's pedigreed bull succumbed in like fashion from a perforation due to a wire nail.

Formerly, primary idiopathic pericarditis was reported. Many of these cases were in children, in whom acute rheumatic infection may exist with little symptomatology. The importance of distant foci of infection was not then recognized, nor was the chronic inflammation of serous membranes due to the toxemia of tuberculosis, known.

It is now generally conceded that pericarditis is secondary to infective processes, the pericardial sac being affected either by direct extension or through the blood.

Rheumatic fever is the commonest cause of pericarditis, at least clinically. It may also follow tonsillitis and chorea. In Osler's[5] series of rheumatic fever patients about six per cent. had pericarditis. Other observers report rheumatic fever as the cause, in percentages varying from three to thirty. There is a seasonal variation. Clinical statistics probably show better the relationship than do post-mortem statistics, as was found by Brooks and Lippencott.[6] These authors found one hundred and fifty cases of pericarditis among a thousand protocols. They studied their patients clinically, bacteriologically, and at post mortem. One is struck by the fewness of the patients with pericarditis strictly of rheumatic origin found at post mortem as shown by these writers. This simply shows that a large portion of patients with rheumatic pericarditis recover, leaving no evidence that can be definitely charged to rheumatism in later life.

Lobar pneumonia is one of the commonest causes of peri-carditis. Seasonal influences play a part in determining the form; in some epidemics fibrinous and serofibrinous forms predominate, but often the purulent form is more in evi-dence. In Brooks's and Lippencott's series of sixty-seven instances of acute serofibrinous pericarditis, twenty-six were due to lobar pneumonia, four had developed in broncho-pneumonia, and three in simple pleurisy without pulmonary involvement. Stone's[7] figures, founded upon three hundred necropsies in pneumonia patients at a time when infections were virulent, are interesting. He recounts his experiences with pneumonia at Fort Riley. According to his summary, pericarditis occurred in twenty-four per cent. of three hun-dred patients, *i.e.,* in seventy-two patients. In round figures, sixty-one per cent. of these had acute purulent pericarditis and the others were equally divided between serofibrinous pericarditis and the subacute fibrinoplastic and purulent form producing the shaggy heart. In acute serofibrinous peri-carditis the quantity of pericardial fluid varied from two hundred and fifty to one thousand cubic centimeters. In this form pneumonia of both lungs was present in fifty per cent. of the patients; of the right lung alone in practically twenty-nine per cent., and of the left lung alone, in twenty-one per cent. The average quantity of pus in the acute purulent pericarditis was three hundred and fifty cubic centimeters, varying from one hundred to one thousand cubic centimeters. In this form, pneumonia involving both lungs occurred in forty-seven and seven-tenths per cent. of cases, involving the left lung alone in thirty-one and eight-tenths per cent., while in twenty and four-tenths per cent. the right lung alone was involved. In fifty-four and five-tenths per cent. of these instances, empyema of the left pleural cavity was present.

In the subacute form of fibrinoplastic and purulent peri-carditis, producing the so-called "shaggy heart," pneumonia of both lungs had occurred in thirty-six per cent. of cases, of the right lung in the same proportion, and of the left lung in twenty-nine per cent. Bilateral empyema had oc-curred in over one-third of these patients. Right and left empyema also occurred, the left being the commoner. The type of organism isolated from the pericardial fluid generally

corresponded to that isolated from the pleural fluid. In about seventy-five per cent. of the patients the infection was streptococcus, usually hemolytic; in this series pericarditis seemed to be largely secondary to empyema, often by extension.

That the type of infection causing intrathoracic suppuration, including pericarditis in epidemics, may vary with locality is illustrated by the experience of Professor Martin[8] of the Pasteur Institute, in 1918. In the early autumn there was a severe outbreak of influenza among the newly mobilized French recruits in the neighborhood of Brest. In those who came to post mortem Martin found the streptococcus almost exclusively. Shortly afterward when he returned to Paris, the outbreak then being rife there, the same observer found that the pneumococcus was almost entirely responsible.

MacLachlan[9] found acute pericarditis present in but seven per cent. of the acute lobar pneumonias in his series. In his experience the streptococcus was more prone to produce suppuration in the pericardial sac than the pneumococcus.

Ordinarily tuberculosis affects the pericardium in two ways, either as a genuine tuberculous pericarditis, with distinct tuberculous lesions, as miliary tubercles or caseous masses, or as a simple fibrous thickening of the membrane, with or without adhesions. In the latter instance, pericardial change is but a local expression of a more or less general fibrosis of the serous membranes. However, tuberculous infection of the pericardium may cause almost any sort of anatomical pericarditis, serofibrinous, hemorrhagic, purulent, plain fibrous or adhesive. These variations may depend upon secondary infections with other organisms. Riesman[10] found tuberculous pericarditis fairly common. MacLachlan, in his series of one hundred cases with pericarditis, found that ten were tuberculous and usually of the serofibrinous variety. He found it might be present without other clinical signs of tuberculosis but at post mortem there was always a primary focus, usually in the lymph nodes of the thorax or in the lung. In miliary tuberculosis, the pericardium was often exempt.

The primary form of tuberculous pericarditis appears to be rare, namely, the condition in which tubercle bacilli or tubercles can be demonstrated in this membrane and not else-

where. Even in the genuine form of tuberculous pericarditis, tuberculous bacteremia appears to be at least as common a cause as localized tuberculosis of the lung or pleura. This statement holds true also for chronic adhesive pericarditis, for in sixty-one patients showing this form, Brooks and Lippencott found that tuberculosis was demonstrated in seventeen cases, indicating it to be a common etiologic factor. Microscopic study may be necessary to reveal the tuberculous nature of a given pericarditis. This holds true for syphilitic pericarditis also. The genuine syphilitic form is uncommon, but on the other hand, chronic fibrosis of the pericardium is probably more often due to this virus than has been recognized. At times, in rather advanced cardiovascular disease of syphilitic origin, one finds a clear cut case of pericarditis.

Arteriosclerosis is one of the factors in chronic adhesive pericarditis. Endocarditis may exist with pericarditis in any form. The two processes are probably due to a common infection. There is little reason for suspecting infection of the pericardium by means of the blood supply from within the heart, or, on the other hand, of the endocardium from the pericardium. This statement was based upon gross pathology but since Rosenow[11] has shown that embolic infection by way of the blood-vessels may involve various cardiac structures, it is conceivable that an infection arising in the endocardium may be distributed by the intracardiac blood supply not only to the myocardium but possibly to the epicardium as well.

Pericarditis may follow puerperal fever, scarlet fever, septic processes in general, and acute necrosis of bone. By extension it may arise from the lungs, pleura, mediastinal and bronchial lymph glands, esophagus, ribs, sternum, vertebra, inflammation below the diaphragm, aneurysm of the aorta, and occasionally with endocarditis. As a terminal process, pericarditis occurs in renal disease, in arteriosclerosis, in scurvy, diabetes, gout, and in almost any chronic illness a latent form may arise. In kidney disease, it is commonest in the acute and the chronic interstitial form. It may occur in any form and its existence may be due to toxic substances or to bacterial invasion. Barach[12] has re-

cently investigated thirty patients with chronic nephritis who developed acute pericarditis. He found a marked nitrogen retention in the blood and a constantly present acidosis. The progressive retention of nitrogen in the blood seemed to be the more important factor. He believes that most cases of pericarditis in chronic nephritis are of non-infectious origin, and that a chemical irritant is probably responsible; even where the fluid yields pyogenic organisms, it is possible that the infection is secondary.

In general, the commonest organisms found in pericarditis are the pus cocci, pneumococci, and the tubercle bacilli. Pericarditis is somewhat commoner in men than in women and may occur at any age. It has arisen from infection of the navel in the newly born. It is common in childhood from association with rheumatic fever and scarlet fever. It is commoner in later life because of association with rheumatic fever, pneumonia, tuberculosis, nephritis, gout and terminal processes.

Clinically, pericarditis may be divided into acute, subacute and chronic; the latter two are often the terminal state of the acute form. In both the acute and chronic forms the inflammatory process is usually more marked on the epicardial than on the parietal layer, even where the lesion is due to direct extension of inflammation from surrounding structures; this may find explanation in the fact that the epicardium has greater vascularity and is subjected to greater physical activity than the outer layer.[6] The acute form may be subdivided into fibrinous, serofibrinous, hemorrhagic and purulent. In the first the exuded serum is rich in coagulated fibrin, in the second, more clear serum collects. For the purposes of description, Osler and McCrae's[5] division into acute fibrinous, pericarditis with effusion, and chronic adhesive pericarditis is most satisfactory.

Acute Fibrinous Pericarditis.

It is the commonest and most benign. It is characterized by the fibrinous exudate and small amount of fluid exuded. The inflammatory change, at first patchy, may become diffuse. It is usually more marked over the base of the heart

and the auricles. The fibrinous deposit varies from a thin
pellicle, causing a lustreless membrane, to a thick deposit
which the activity of the adjacent surfaces molds into a
honeycomb or buttered bread surface. When the fibrin is
in long shreds, the heart has the appearance called shaggy
or hairy; in healing, the little fluid enmeshed in the fibrinous
deposit is absorbed and the opposed abraded surfaces adhere;
thus local synechiæ or general adhesions of surfaces arise.

In the milder acute form, the heart muscle may escape.
In severe attacks, the myocardium is inflamed beneath the
epicardium to a depth of from one to two millimeters.

Recognition. Fever may be slight or marked, depending upon
the primary disease. Pain is not a constant feature; Robey[13]
found it in but twenty-five per cent. of his cases, but it may
be severe and early and first draw attention to the heart.
It may be precordial or epigastric, thus it may be referred
to the abdomen and simulate appendicitis, as reaffirmed by
Fussell and Kay.[14] It sometimes simulates angina pectoris,
especially when it is paroxysmal and intense. The compara-
tive youth of the patient, the previous history of rheumatic
fever, the unusual radiation of the pain, and finally the de-
tection of the friction sound have revealed the true nature
of the complaint in some cases I have seen. There may be
an area of marked hyperesthesia in the precordial region.
The *friction sound*, due to the rubbing upon each other of
the two pericardial layers, is the most distinctive sign of
pericarditis. It is more commonly heard in the third and
fourth interspaces, over the right ventricle, sometimes as
high as the second rib. It may be better heard over the
base or at the apex. It is a to-and-fro superficial rubbing
or grating, jerky sound, sometimes intensified by pressure of
the stethoscope. It may be limited or transmitted up and
down the sternum. Its direction is never as constant as that
of endocardial murmurs. It is usually double, may be sin-
gle; it may be triple and simulate a gallop rhythm; it may
disappear and reappear and change its location; the quality
of the sound often varies; it may be well marked in systole
and faint in diastole; if heard alone at the apex it may sim-
ulate a presystolic murmur; if most intense at the base, it
may resemble a double aortic murmur. The size of the heart,

the water hammer pulse, pulse pressure, and presence of a distinct aortic second sound, should distinguish the two. The existence of a friction sound does not exclude fluid, as we shall see later. Pleural and pleuro-pericardial friction simulate the ordinary pericardial friction, but the former two are definitely modified by respiration. Holding the breath or taking a deep inspiration may abolish them. They are more commonly heard over the left border of· the heart and are often present in pneumonia and· tuberculosis. A palpable thrill may or may not be present in pericarditis.

In his article on acute pericarditis, Robey,[13] in discussing pericardial effusions, says: "In these cases, almost all authors—Billings, Babcock, J. Mackenzie, Cabot, Musser, Parkinson—call attention to the small area of dullness in the left back, just inside the angle of the scapula, described by Ewart, and produced by mechanical atelectasis of the compressed lung." The authors quoted, as well as Bamberger, evidently had pericardial effusion of considerable size, in mind. Christian[15] draws attention to the fact that this area of dullness may occur about the angle of the scapula or involve the lower half of the back in cases of fibrinous pericarditis, especially of rheumatic origin, where there is but little pericardial effusion.

Patients do not succumb from simple fibrinous pericarditis alone; some cases may heal without adhesions. More commonly as the inflammation subsides, the fibrinous layers are transformed into connective tissue joining the pericardial surfaces firmly together. On the other hand, the inflammation often terminates in the serofibrinous form with much effusion. Occasionally, simple fibrinous pericarditis becomes chronic and a gradual marked thickening of the two layers of pericardial sac follows.

Pericarditis With Effusion.

This form often follows the acute fibrinous form and is a complication of rheumatic fever, pneumonia, tuberculosis and septic processes. The effusion may be serofibrinous, seropurulent, purulent or hemorrhagic; in the serofibrinous form, the pericardial layers are covered with fibrin as in

the simple fibrinous form, but in addition there is a marked exuding of serum. Hydropericardium occurs in general dropsy due to kidney or heart disease, especially the former. Transudation into the pleural cavities is apt to be present at the same time. In both the amounts may be large. Purulent pericarditis may arise either directly from infection of the pericardium or from infection with pyogenic microörganisms of the exudate in the serofibrinous form. The commonest organisms found in this condition are tubercle bacilli, pneumococci, streptococci, and staphylococci. The pericardial surfaces are gray, granular, and the epicardium may show erosions. In this form especially the superficial myocardium may show fatty and granular change. Extensive fibrous adhesions and sometimes patches of calcification follow recovery from purulent pericarditis.

Hemorrhagic pericarditis may arise simply by extravasation of blood cells into a serofibrinous or purulent exudate. It may occur in any severe type of pericardial inflammation. It has been reported in tuberculosis, in uremia, and leukemia. In purpura, scurvy, and invasion of the pericardium by new growths, there may be direct extravasation of blood in the pericardial sac, with minimal signs of inflammation. Hemopericardium occurs in aneurysm of the first part of the aorta or of the coronary arteries and in rupture and wounds of the heart. The only symptoms may be those of rapid heart failure.

The normal pericardium contains a few cubic centimeters of fluid evenly distributed for the purposes of lubrication. In the rheumatic group a demonstrable amount of fluid may appear and be absorbed. Ordinarily, the amount of fluid in pericarditis with effusion varies from two hundred cubic centimeters to two liters. In patients with tuberculous pericarditis, the amount may be large. Thayer[16] removed 1250 cubic centimeters from a patient; Musser,[17] 1100 cubic centimeters during life and 1920 cubic centimeters at post mortem; Verney[18] reports a patient from whom 4000 cubic centimeters were removed, and Kay reports one from whom 3500 to 4000 cubic centimeters were removed. These variations in amounts seem to bear out the statement of Mackenzie[19] that normally

the pericardium is inelastic but with inflammation it becomes distensible.

Symptoms and Signs. Pericarditis with effusion may occur insidiously without pain; or there may be distress, discomfort and oppression; in some patients the pain may be sharp and stabbing. Osler and McCrae[5] state that it is more frequent than in the simple plastic form, and that pressure upon the lower end of the sternum increases it.

Possibly pain in pericarditis is commoner than is recognized. It is so frequently associated with pneumonia with pleurisy, and with pleurisy alone—in one hundred and thirty-six patients at post mortem out of the one hundred and fifty with pericarditis in Brooks's and Lippencott's series—that the pericardial inflammation is overlooked. Clinically, pericarditis following in the wake of pleurisy is said to be rare, but evidently from the above figures the association is common at post mortem. Pain simulating angina pectoris, as described by Allbutt, is encountered occasionally. Pain is more apt to occur early when the sac begins to distend. Precordial tenderness is a frequent association.

Pericardial Friction. The to-and-fro friction rub is probably present in every case at some time in its course. Its characteristics have been dwelt upon under the simple fibrinous form. The friction rub may persist even with very large effusions. Williamson[20] found it present in more than two-thirds of his patients; the reason given for its presence being that a relatively large heart, often associated with pre-existing valve lesion, fully filling in the space between the vertebra and sternum, comes in contact with the sternum.

Pericardial Effusion. Williamson shows, from both experimental and clinical evidence that pericardial exudate accumulates earliest about the apex and on the diaphragmatic surface, especially in the costo-diaphragmatic angle. With effusions of from 240 cubic centimeters up, the accumulation at this site is manifested clinically by a pushing down of the left lobe of the liver. With effusions of from 500 to 600 cubic centimeters, he found the left lobe of the liver depressed as much as two finger breadths. This may be a valuable clinical sign, especially if the patient's condition is studied from the beginning of the disease. The second place in which fluid

accumulates is over the great vessels at the base; even with small amounts, it may be detected by percussion; with larger amounts, this retrosternal dullness is an important diagnostic sign. Morris and Bader,[21] from their injection experiments, found the restrosternal dullness a most striking change. In the recumbent posture their findings seem to indicate that about 500 cubic centimeters of fluid must be present to give clear indications of this dullness by percussion.

With increasing effusion, the adjacent lung is pushed aside and well developed precordial dullness, triangular or pear-shaped, with the base downward, is found. There may be an increased convexity of the right border of the heart; the cardio-hepatic angle may be transformed from a right angle to an obtuse one (Epstein); also there may be dullness in the right fifth interspace, close to the sternum. (Rotch's sign.) Neither of these signs is constant. There may be an upward increase of dullness as far as the second interspace; in large effusions, the first rib may be separated from the clavicle and felt throughout its length. The distended pericardial sac may exert sufficient pressure within the thorax to cause distension of the veins of the neck, dysphagia, cough from tracheal pressure, and aphonia from pressure upon the left recurrent laryngeal nerve. As already mentioned, dullness and bronchial breathing about the lower angle of the left scapula, and perhaps involving the whole left lower base, may be an early sign. With large effusions, the left lower lobe may be so pushed aside and compressed, that even in the left axillary region, the area below the transverse nipple line may be dull and the breath sounds feeble or bronchial. Dullness or flatness due to effusion in the sac alone rarely reaches below the eighth rib in the left axilla. Flatness below this is probably due to coincident pleural disease, while dullness may be due to the compression of the lung in large effusions. Shifting of dullness with a change of the patient's position is usually not a helpful sign in pericardial effusion. The dullness about the inferior angle of the left scapula, as Bamberger pointed out, may disappear when the patient leans forward.

The apex beat may be displaced, it may be diminished or lost. With large effusions, the heart sounds are apt to be

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feeble, the pulse is rapid, sometimes irregular, and occasionally pulsus paradoxus is present, in which in full inspiration the pulse becomes very feeble or is lost. In pericarditis, the fever is often not distinctive; occasionally, in the purulent form, it may be intermittent. Dyspnea may be a marked symptom and the face is often dusky and anxious. Insomnia, delirium, coma, and depressive mental conditions have all been reported as existing in certain patients with pericarditis.

Diagnosis. The most characteristic sign of pericarditis is the friction rub. That the diagnosis is so frequently missed clinically is probably due largely to the fact that the signs of pericarditis are masked by the signs and symptoms of the primary complaint. Again, its onset may be insidious. Fever may be present several days before one can detect the friction rub which fixes the diagnosis. It is possible that in such patients the inflammation begins on the posterior aspect of the heart. It may be difficult, especially if the precordial dullness is established when the patient is first seen, to say that one is dealing with pericardial effusion. It is necessary to differentiate a dilated heart, and pleural effusion, especially the encysted form. Again, in pericarditis complicating pneumonia, it may be especially difficult because of the lung and pleural conditions. Some points that may be helpful in differentiating cardiac dilatation from pericardial effusion are: The area of dullness in dilatation is not apt to have a triangular form; in dilatation, when dullness extends into the left sixth interspace, the apex beat can more often be seen or felt; in dilatation, the heart sounds are more often evident, though fetal in character; in effusion, they are more apt to be muffled; percussion dullness about the left inferior angle of the scapula is common in pericardial effusion, uncommon in dilatation of the heart; in those patients where the apex impulse is distinctly displaced, especially other than outward and downward, or where it is obliterated, the condition is more apt to be effusion. Occasionally, the x-ray may give distinct help. At the bedside, the differentiation may be extremely difficult. Again, it may be hard to differentiate satisfactorily pericardial effusion from pleural effusion. Shifting dullness in pleural effusion is a helpful sign, but of little value in pericardial effusion. Where the infra-

scapular dullness is localized, as we have seen, it suggests
pericardial effusion; a lost apex beat and muffled heart sounds
are suggestive. Those who have had much experience with
the fluoroscope think they have obtained much help in dif-
ferentiating these complicated conditions.

Stone found the physical signs and the roentgenograms
were fairly dependable with pericardial effusion in amounts
varying from 300 to 500 cubic centimeters, despite the exten-
sive, associated pathologic condition, which confused the
picture. In the diagnosis of smaller amounts of purulent
material in the pericardium, say from 10 to 150 cubic centi-
meters, neither the clinical signs nor the roentgenograms
were of much assistance.

Treatment. Especially in the rheumatic form of pericar-
ditis, demonstrable amounts of fluid may be absorbed. Ac-
cording to Christian, pericarditis in adults. with an amount
of fluid requiring tapping, is comparatively uncommon in
general hospital experience. The indications for paracentesis
are increasing dyspnea, cyanosis, and cardiac embarrassment.

Tapping the Pericardium. Williamson's advice invariably to
tap the pericardium, in the apex area far enough out to be
sure one is outside of the apex, by inserting a needle in either
the fifth or sixth interspace, and pushing it upward, back-
ward and inward, is good in the majority of cases. He con-
siders this much safer than going either to the right or left
of the sternum. Where a local friction rub persists, it is
wise to avoid that area in tapping, also an area where the
heart sounds are distinct. Camac and Pool[22] give the fol-
lowing three sites as most suitable for paracentesis of the
pericardium : (1) A point slightly internal to the left limit
of dullness in the fifth or sixth intercostal space. (2) The
midline immediately below the xiphoid process, because the
pericardium at this point is reached by the shortest route
without injury to the blood-vessels, pleura, and peritoneum
and the exudate may be evacuated before the heart is
touched. Extreme malformation of the sternum and a high
degree of tympanites contraindicate this method. In this
method, under local anesthesia, the needle or trocar is
pushed directly upward two centimeters, keeping close to
the posterior surface of the xiphoid. The object is to avoid

the peritoneum. After passing through the diaphragm, the point of the needle is directed upward and backward. (3) A point in the angle formed by the base of the xiphoid process and the seventh left cartilage at its insertion. Under ordinary circumstances, the fifth or sixth interspaces, outside of the apex, appear to me decidedly preferable.

Aspiration is most often sufficient where the exudate is serofibrinous. But where the fluid is purulent the pericardium should be freely drained by surgical means. In such cases the freer the incision and the drainage, the better is the outlook for recovery. Other indications for treatment are, first of all, that of the primary disease; where it is rheumatic fever, the usual course of salicylate and soda bicarbonate may be continued. Sufficient morphia or codein must be used to relieve pain. To quiet the heart and possibly to check the progress of disease and possibly lessen effusion, the ice bag should be used, intermittently or continuously. It should not be too heavy and at least one layer of clothing should be left between the bag and the skin. If the pulse is rapid and the circulation poor, digitalis may be given. Potassium citrate may be used to stimulate the kidney. Marked purging or diaphoresis for the purpose of removing the effusion, is not desirable. Small blisters applied to the precordia have been thought to promote the absorption of the exudate. They may be tried where small effusions persist, but should not be used, of course, where pericarditis is secondary to nephritis. With a persistent rub, or even with small effusion, iodide of potash may be tried. The diet should be dry and easily digested. Prolonged rest, both physical and mental, is desirable, both early and during convalescence.

Chronic Adhesive Pericarditis.

Patients with adherent pericardium fall into three groups: *First,* the group in which the pericarditis runs a silent course, practically without symptoms, and the condition is discovered at autopsy. There is an adhesion of the two layers of the pericardium, often without even dilatation or hypertrophy or disturbed function of the heart accom-

panying this condition. *Second,* the adherent pericardium is associated with chronic mediastinitis and union with the pleura and chest walls; this leads to extreme hypertrophy and dilatation of the heart, and in the end usually leads to disturbed cardiac action and failure. The *third* group is marked by ascites, with but little edema of the legs; the condition is usually diagnosed as cirrhosis of the liver; these patients show, on post mortem, chronic obliterative pericarditis, pleuritis, peritonitis, perihepatitis, and certain forms of cirrhosis of the liver. This is the condition described by Pick in 1896; it is known as Pick's disease, or as the "iced liver" of Curschmann, and also as multiple serositis.

As has been intimated, the diagnosis of the first is usually not made clinically, and multiple serositis is comparatively uncommon. The second group is commoner; it is a common complication and cause of cardiac breakdown in youth, but some of my patients have succumbed between twenty-five and thirty. Though there are no pathognomonic signs, the condition is often capable of diagnosis. The following are suggestive points:

First, a marked enlargement of the heart, which may be diagnosed by the percussion dullness, and also from the extent of the cardiac impulse. The latter may be seen from the third to the sixth interspaces, and from the right border of the sternum to outside the left nipple line. Broadbent pointed out the fact that when the heart is adherent to the diaphragm there may be a systolic tug with each beat, which causes retraction of intercostal spaces; common sites are, in the apex region, in the region of the seventh and eighth ribs, just to the left of the sternum, in midaxilla on the left side; also, posteriorly on the left side between the eleventh and twelfth ribs. Though it may occur in thin people, with great hypertrophy of the heart as suggested by Tallant, it remains one of the most valuable signs. Respiratory movements are absent in the epigastric triangle; pulsus paradoxus, the pulse becoming weaker during inspiration, and diastolic collapse of the veins of the neck, are not important signs. The diastolic shock of rebound appears more important; also the fixation of the apex beat. This may not alter when the patient

breathes deeply or lies upon the left side. Endocardial murmurs are usually present, either from genuine endocarditis or from relative insufficiency; these murmurs are commoner at the mitral, tricuspid or pulmonary. Adherent pericardium is apt to be found in children with valvular lesions with a markedly enlarged heart. It may be suspected in any patient, showing suggestive signs if there has been a history of a friction sound at some earlier date. Brauer's operation, known as cardiolysis, may give relief; it consists in removing several centimeters of the fourth, fifth and sixth left ribs and cartilages; it is an operation applicable in a few selected cases. The indications for medical treatment are to support the failing myocardium; it is usually too late when these patients come under observation, to do much for the causative factors.

THE MYOCARDIUM.

Until two decades ago the study of heart disease was concerned almost exclusively with valvular disease and the pericardium. Some attention was also given to determining the existence of hypertrophy and dilatation and their differentiation. This is understandable because diagnosis was confined to the evidence afforded by physical signs and an attempt to determine the structural changes responsible for these abnormal findings. Etiology received some attention but cardiac function as a whole, practically none at all. Irregular action of the heart was not assessed because as yet there were no means of definite differentiation, and all the irregularities were put down under the simple head of arrhythmia.

Two things gave a new turn to the study of heart disease and especially myocardial function. The first was the discovery of the anatomical existence, and the determination of the functions of the sino-auricular node and the auriculo-ventricular connecting system. The second was the perfection of two clinical instruments—the polygraph and the electrocardiograph—both of which enabled us to detect the activities of the upper and lower chambers of the heart and their time relationship to each other; to determine the condition of that important function of the cardiac muscle, con-

ductivity; and to resolve the irregularity of the heart into several varieties. These studies afforded most valuable information because they were objective; their findings were graphically recorded; and the curves from the heart at one period could be compared with those of months or years later. The information supplied by these instruments has rendered diagnosis more precise, has influenced prognosis, because for the first time we are able to pry into the functional condition of the cardiac muscle, and has influenced treatment by graphically demonstrating the effect of certain drugs upon the heart and thus clearly indicating when they are needed and when they should be stopped. Perhaps the greatest advance clinically derived from graphic methods has been the training in exact observation of workers in heart disease. It is not necessary that all should make use of these instruments personally, but it is necessary that all should be conversant with the findings they afford, for with this knowledge in mind, one can diagnose a large percentage of cardiac abnormalities without recourse to instrumental means. On the whole, their use tends to simplify rather than to complicate the study of heart disease.

In the study of the myocardium especially, we realize at every step our indebtedness to Sir Thomas Lewis,[23] both for his experimental and clinical work and for his collection and critical analysis of the literature of this subject.

The next step will be to consider these special anatomical structures and their function:

The Sino-Auricular Node. The *S-A* node lies at the junction of the superior vena cava and the right auricle in the head of the sulcus terminalis, extends down along the sulcus terminalis for 2 cm. and is 2 mm. thick. Its structure is neuro-muscular. In the human heart the muscle fibers are small, striated, fusiform, nucleated, networklike in arrangement, and imbedded in dense connective tissue. The ganglia are few but the nerve fibers and cells are plentiful and connected with the vagus and sympathetic nerve trunks. There is a special blood supply, the nodal artery springing from the right coronary. The normal heart beat originates in this node, spreads over the walls of the auricle and thus reaches the auriculo-ventricular connecting tissues.

THE AURICULO-VENTRICULAR CONNECTING SYSTEM.

Anatomy. The *A-V* system, also known as the junctional tissues, consists of the following:

1. The auricular node (auriculo-nodal junction).
2. The auriculo-ventricular node (Tawara).
3. The bundle proper. (The Bundle of His.)
4. The right and left divisions of the bundle.
5. The arborizations and the network of Purkinje.
6. The transitional fibers between the Purkinje's network and the ventricular muscle substance.

The auricular node is simply the upper part of the *auriculo-ventricular node*. It is mentioned to emphasize the necessity of not confusing it in our reading with the *S-A* node. The *A-V* node lies in the auricle near the coronary sinus and at the base of the auricular septum. This node has fine fibers, a good vascular supply and often a profusion of nerve fibers and ganglia are demonstrable.

The *bundle* proper, 1 mm. to 2mm. thick, begins at the *A-V* node, and, sheathed in a canal, runs forward to the left and at the membraneous septum divides, the left branch passing through this septum. This *left branch,* still ensheathed, becomes subendocardial in the left ventricle, immediately beneath the point where anterior and right posterior aortic cusps unite. Its further course is downward on to the septum where its arborization begins, two main branches passing to the papillary muscles of the mitral valve. The *right branch,* becoming subendocardial, follows the moderator band to the papillary muscles, where it passes into arborization. The arborizations of both branches are directly continuous with the subendocardial network of *Purkinje's fibers,* which line the interior of both ventricles. From the Purkinje network there is direct communication with the ventricular muscle fibers. Thus the junction tissues may be traced from the auricle to the ventricle without a break.

The Purkinje type of fibers may be found as high up as the main branches of the Bundle but they are less marked in the human heart. This observation is of importance, since these fibers are endowed with the highest degree of conduc-

tivity of any fibers of the heart. The persistence of connective tissue sheaths about the fibers (Fig. 1) of the *A-V* conducting system, often through their whole course, allows the system to be injected with India ink and in many species (calf, sheep, ox) shows beautifully their distribution. (Fig. 2.) Furthermore, from Bundle to arborization the fibers are all rich in glycogen, which allows a distinct display by staining.

Fig. 1.—High power micro-photograph of a small bundle of Purkinje fibers, showing a delicate sheath of connective tissue surrounding each fiber. (*Dr. John Eiman.*)

Physiology. The *S-A* node lies in the head of the sulcus terminalis and is the normal pacemaker of the heart. Normally, it generates impulses regularly at the rate of seventy-two to eighty per minute. It is the pacemaker by virtue of the rapidity of its stimulus production. If this function of the *S-A* node is depressed, or the excitability of some other center of the heart is increased, the more excitable center may, at least temporarily, become the pacemaker. Other areas of the auricular wall are capable of generating rhythmic impulses, but it has not been proven that such areas

do not contain nodal tissue. The rhythm originating in these so-called ectopic centers is not apt to be sustained. The result of impulse formation is the excitation wave, by which is meant a wave of altered electrical conditions which flows over the muscle preparatory to its contraction. It is the earliest evidence of muscular activity we possess and precedes the contraction wave by a few hundredths of a second. Such an excitation wave arising in the *S-A* node spreads immediately at the rate of about 1000 mm. per second along the ordinary auricular muscle bands which radiate from the *S-A* node to the *A-V* node. The complete wave in the auricle occupies four-hundredths to five-hundredths of one second. It should be emphasized that conduction from the *S-A* node to the *A-V* node is through the ordinary auricular musculature. No fibers comparable to those of the *A-V* conducting system have ever been satisfactorily demonstrated in the auricle.

Physiologically the muscles of the two auricles are considered as constituting one undivided mass, and here one may add that, according to Lewis,[24] both clinical and experimental evidence fails to show that the two ventricles are ever disassociated, that is, beat independently. Physiologically, the two ventricles also may be looked upon as one continuous tissue. Ventricular hemisystole does not exist. The auriculo-ventricular connecting system is the sole functional connection between the upper and lower chambers of the heart. It is also referred to as the auriculo-ventricular conducting system because the chief function of this structure is to transmit auricular impulses to the ventricle and thus incite contraction of the latter. That a normal ventricular rhythm depends upon impulses due to previous auricular contraction carried to the ventricle by way of the junctional tissues has been proven repeatedly and the technique is such that in the hands of the experienced it can be repeated at will with always the same results. Thus, experimental complete trans-section of the *A-V* bundle results in complete dissociation, the auricles and ventricles continuing to beat but at independent rates, the auricles at about their previous rate, the ventricles at a rate much slower—about half the preceding rate. This new ventricular rhythm is due to a

new center, in the A-V bundle below the seat of injury, becoming the ventricular pacemaker. Again, with a suitable clamp, gripping the A-V bundle in experiment, graduated increased pressure will produce increasing degrees of partial

Fig. 2.—Unretouched photograph of part of left ventricle of a beef heart showing branches of the left division of the auriculo-ventricular bundle and its arborizations (A). The sheaths of these structures have been injected with India ink. (*Dr. John Eiman.*)

heart block and finally, if the pressure is sufficient, complete heart block. It has been found that a single undamaged strand of the main bundle, with its two main branches intact, or the intact main bundle with one intact branch, is

sufficient to transmit impulses. This last statement is im-
portant because though the results of disease have prac-
tically the same effect on the conducting function of the
A-V bundle as experimental procedures, naturally the re-
sults are not always as clear cut, and, furthermore, cases of
block have been found where a sufficient lesion to explain
it has not been demonstrated. But when one considers the
thousands of sections to be studied, even when the A-V
node and main bundle alone are examined serially, one should
place the fault upon our histologic limitations, especially in
the face of experimental evidence. Drugs may also affect
conduction in the A-V bundle, as well as vagal stimulation,
as we shall see later. The result of both experimental and
clinical studies is the conclusion that an impulse arising in
the auricle is transmitted to the ventricle by the A-V bundle
and by this pathway alone.

From the foregoing conclusions and from the anatomical
facts one would naturally suspect that the distribution of
the excitation wave would spread throughout the ventricle
by means of the network of bundle branches and its arboriza-
tions (Purkinje fiber pathway). Experimental results sup-
port this supposition; experimental study of the surface dis-
tribution of the excitation wave upon the ventricular surface
shows that in spite of the thickness of its muscle walls and
its slow conduction rate, the whole surface of the ventricle
is supplied in three-hundredths of one second or less; while
in the thin walled auricle the time of the wave, from start
to finish, was between four-hundredths and five-hundredths
of one second. Knowing that the rate of spread on the ven-
tricular surface was about 500 mm. per second, ventricular
activity due to contiguous muscle spread in the ventricle is
inconceivable. Also, the arrangement of the muscle bands
is complicated in the ventricle and does not affect the spread
favorably as it does in the auricle.

Again, it has been demonstrated that a slight injury to a
given part of the endocardium (which immediately covers
the arborizations and Purkinje fibers) delays conduction in
that area, while a similar injury to the epicardium has no
effect. Thus it was shown that the spread is along the endo-
cardial surface and that the excitation wave spreads from

within outward through the ventricular muscle. It was also determined that the distribution of the excitation wave on any point of the ventricular surface is dependent upon the length of the Purkinje path and the thickness of the ventricular wall at that point. The thinness of the wall explains the early activity of the apex of the left ventricle. The results of these experiments allow us to affirm that the large thick ventricular mass receives its impulses by way of the distal subdivisions of the *A-V* system, and that this part of the system has the most rapid transmission of conduction known—about 5000 mm. per second—so that the ventricles are activated and contract almost simultaneously at all parts.

Since the Purkinje system lines the whole of the ventricular cavity and lies just beneath the endocardium, it is easy to see why in endocarditis the heart is apt to be more profoundly affected than in pericarditis. In many cases of pericarditis the post mortem findings show that the ventricular wall is affected to the depth of 2 or 3 mm., with a comparatively little disturbance of the function of the heart. But when we consider how such inflammatory changes in the interior of the heart may affect not only the endocardium but especially this remarkable conducting system, it is easy to see how much more profoundly the inflammatory changes here may impair the functional integrity of the heart. Besides having the function of conduction, the *A-V* node and the main bundle may under certain circumstances become the pacemaker of the heart. They have a certain degree of rhythmicity. It has also been shown that the main branches of the bundle as well as the bundle itself, though they usually conduct impulses in one direction, are able to conduct in either direction. Due to this fact, an impulse arising in the region of the *A-V* node can stimulate auricle and ventricle so that they contract practically simultaneously.

THE INFLUENCE OF THE VAGI UPON THESE SPECIAL STRUCTURES.

Unfortunately, we have no knowledge of the action of the intrinsic cardiac ganglia nor of the sympathetic nerve trunks upon the diseased heart, which serves any clinical purpose. Concerning the action of the vagi upon the heart, we have

some definite knowledge, both experimental and clinical; the vagus is the inhibitory nerve of the heart. Stimulation of this nerve affects the force of auricular and ventricular contraction but its predominant influence is upon the primitive tissues, *i.e.*, the sino-auricular and auriculo-ventricular nodes, and upon the junctional tissues as a whole. Mild stimulation of the right vagus slows the whole heart by its influence upon the sino-auricular node. Stronger stimulation produces cardiac standstill for the same reason. The slow action of the heart in the right vagal stimulation then is due to a depression of the function of impulse formation in the sino-auricular node. Both in experiment and in the human subject this slowing is sometimes due to the displacement of the pacemaker from the head to the tail of the *S-A* node.

The auriculo-ventricular node is made up of fine fibres with low conducting power; its function is easily depressed by vagal stimulation, the left nerve especially when stimulated causes auriculo-ventricular block. The right appears to effect a similar influence but is less active. The effect of vagal stimulation is not confined to the *A-V* node and main bundle, but it extends to the divisions of the bundle, for when partial heart block is produced by vagal stimulation, ventricular responses of aberrant type are seen. Wilson[25] has recorded this experience in man.

There is no definite relation between the side on which the nerve is stimulated and the branch which is affected. Vagal stimulation in man in health, then, may show slowing of the whole heart, standstill, heart block, and where the ventricular diastoles are long there may be ventricular escape. The right nerve is more potent in depressing impulse formation in the *S-A* node (slowing, standstill), the left in producing heart block, according to Robinson and Draper.[26] Digital compression of the vagus is used clinically to slow the heart in paroxysmal tachycardia and auricular flutter. The occulo-motor reflex is used for the same purpose. Pressure is made by the fingers upon the closed eyelids for several seconds. Often the slowing, which is due ·to reflex vagal influences, is conspicuous. The further consideration of vagal influences upon the heart will fall naturally under the head of sinus irregularity.

THE POLYGRAPHIC METHOD OF STUDY.

Polygraphic Curves. Disturbed myocardial function, with few exceptions, leads to disordered heart action. Any instrument which will record the sequence of contraction of the upper and lower chambers of the heart is useful in analyzing these irregularities. The polygraph is such an apparatus. It records changing intravascular pressures which in turn represent auricular and ventricular activity. A shallow, air-tight receiver pressed lightly over a vessel transmits its pulsations by air through a connecting rubber tube to a tambour carrying a recording pen. Arterial pulsations in carotid, brachial and radial are readily recognized. (Fig. 3.) Clinically, the up stroke of the polygraphic tracing of the pulse beat in these arteries is taken as the signal of left ventricular systole. The up stroke in the radial curve occurs one-tenth of one second after the up stroke of the carotid, and this interval must be allowed for in the interpretation of curves. In brachial curves, the up stroke, if taken one-tenth of one second after the carotid, will be accurate enough for practical purposes. It must be remembered that all clinical curves are more or less crude and not comparable to those of the more delicate laboratory apparatus. Frequently these arterial curves show a dicrotic notch and though the distance from the up stroke to dicrotic notch is but an inexact measure of the length of ventricular systole in the arteries, still this notch is the best means we have and may be used in these curves to fix the *v* wave in the venous curve. In arterial curves the up stroke of each pulse beat is practically exact, so that the intervals between up strokes are taken as standard measurements.

Venous Curves. Clinically, these are taken from the jugular vein. Pulsations in veins are not so evident as in arteries; however, though small, they may be recorded. The movements in veins due to cardiac activity may be made more evident by any procedure which increases intrathoracic pressure, as recumbency, abdominal pressure, and especially holding the breath in full expiration. The latter procedure usually aids in getting excellent curves, for not only are the veins fuller but the interference of respiratory movement is
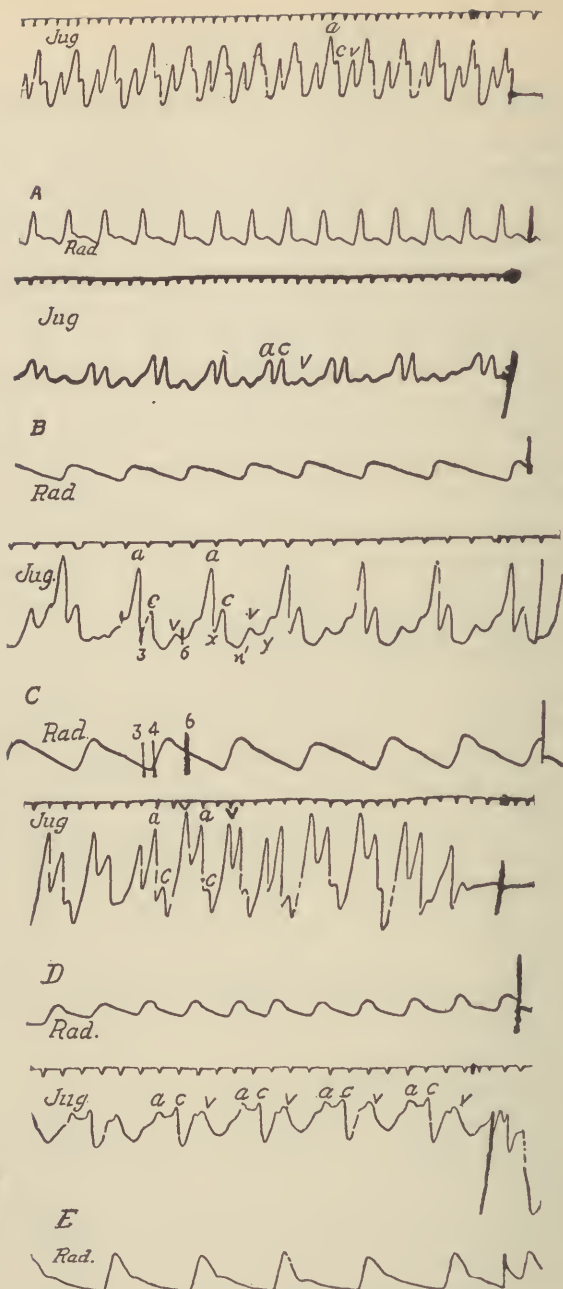
Fig. 3.—Nos. *A* to *E*, all show normal forms of the venous pulse. Note the regular recurring *a, c,* and *v* waves. In *E* the *v* wave shows a slight depression. This is often much deeper, dividing the wave into two parts. The time marks are one-fifth of a second.

(208)

obviated. Satisfactory curves can be secured in practically all normal individuals. They are taken from the right jugular bulb, which lies just above and an inch external to the sternal end of the clavicle. This point lies nearer the heart and the waves record approximately the movement of the right auricle, its contraction hinders the flow of blood from the vein and possibly there is also a slight reflux into the vein from the contracting auricle. The venous pulse (Fig. 3 C) consists of three upright waves and three chief depressions. In Mackenzie's nomenclature, they are the a, c, v waves and depressions x, x', and y. The a wave represents auricular systole.

The c wave is probably partly venous but is largely due to the shock transmitted from the carotid artery. It is taken as an index of left ventricular systole.

The v wave is due to stasis. The blood accumulates in the auricle while the ventricle is in systole. In some clinical curves, v is double.

In the ventricular form of venous pulse c and v waves alone are present. There is no a wave, because in this abnormal condition the auricle is at a functional standstill.

X and x' lie on either side of c. They are part of a long down stroke broken by c and are due to three factors, namely, relaxation of the auricular wall, the increase of negative pressure in the thorax, due to ventricular systole, and the drag upon the auriculo-ventricular ring by the contracting ventricle.

The y depression expresses the fall of intra-auricular pressure which begins at the opening of the auriculo-ventricular valves. The b or h wave which one sees sometimes inscribed in curves occurs when diastole is long and is said to be caused by the floating up of the tricuspid segment and closure of the valve in early diastole as the ventricle fills with blood.

In clinical work the onset of a in the venous curves indicates the contraction of the auricle. The a-c interval, the recorded distance between the up strokes of the a and c waves, is used as a measure of the auriculo-ventricular systolic interval and this is taken as an index of the capacity of the tissues to conduct impulses from auricle to ventricle.

14

The *a-c* interval normally varies from 0.1 to 0.2 of one second. Any increase beyond one-fifth of one second is considered abnormal and spoken of as prolonged conduction.

The Analysis of a Tracing. Mackenzie[19] used the radial pulse as a standard. In Fig. 3 C, we analyze the tracing thus: A line is drawn at 4, at the foot of the up stroke of the radial and parallel with the ordinate at the extreme right. One-tenth of one second to the left of 4 the parallel line 3 is drawn, as the carotid pulse occurs one-tenth of one second before the radial. The distance from ordinate to three when transferred to the jugular curve will fall at the up stroke of a small wave, which must be due to the
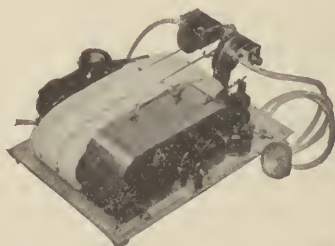
Fig 4.—Sanborn polygraph.

carotid and so is marked *c*. The auricular wave normally falls one-fifth of one second in front of *c*. The bottom of the dicrotic notch represents the opening of the tricuspid valve. If a perpendicular line, 6, is drawn through the dicrotic notch on the radial and this distance transferred to the jugular, the point 6 should fall at the end of the wave, *v*.

Another method of fixing *c* waves in a strip of radial curve is to lay a straight edged piece of paper along the bottom of the curve, mark the ordinate and the upstroke of each radial beat, transfer the strip to the venous curve, applying ordinate to ordinate, make allowance for the one-tenth of one second by moving your slip of paper one-tenth of one second to the left—if the ordinate to the right is used, or *vice versa*. Each dot represents the foot of a pulse beat and should fall at the up stroke of a wave which is *c*.

In practical bedside work, the use of the polygraph is largely confined to the taking of radial or brachial pulse

curves and venous curves. The same apparatus will record
the maximal thrust of the left ventricle, and in many cases
with pulsating epigastrium, the right ventricular contraction
can be recorded. With a much larger receiver, curves can
be taken of a pulsating liver. With a small rubber bag, at-
tached lightly to the chest or epigastrium, excellent curves
of respiration can be taken. A hollow metal sound, tipped
with a small inflatable rubber bag, has been passed into the
esophagus in man and records of the activity of the left auri-
cle have been made. This is evidently not a clinical pro-
cedure. The most satisfactory clinical polygraphs are the
Mackenzie, the modification made by Lewis, and a somewhat
similar one constructed by the Sanborn Company. The dif-
ficulty with the original Mackenzie was the time consumed
in many cases in adjusting the splint to the radial so as to
get a satisfactory curve. This is obviated entirely by using
an Erlanger capsule and blood-pressure cuff with this instru-
ment. In the Lewis and in the Sanborn instruments, a
glycerine pelotte is used as a receiver for the radial or the
brachial. More than two recording tambour pens and a time
marker are difficult to manipulate.

THE ELECTROCARDIOGRAPHIC METHOD OF STUDY.

The Electrocardiographic Method. We now turn to elec-
tric methods in the study of the functional impairment of
the all-important myocardium. In 1856 Kölliker and Müller
demonstrated the presence of an electric current in the beat-
ing heart. In 1903 Einthoven[27] introduced his sensitive
string galvanometer which is the core of the electrocardio-
graph, an instrument practical for both experimental and
clinical work. Fortunately, the currents led off from the
extremities of the patient yield exactly the same curves as
when taken from the chest wall immediately over the heart
or from electrodes placed immediately upon the heart itself.
The instrument consists of a string galvanometer in which
the thin fiber of silvered glass or platinum, 0.002 to 0.005 mm.
in thickness, is suspended between the poles of the strong
magnet. When the minute electric current from the heart
passes through this string the latter moves with each heart
beat at right angles to the field of magnetic force. Micro-

scope lenses magnify the string, the shadow of which is projected upon the slit of a camera by a strong light, and a moving plate or film within records graphically the activity of the auricle and the ventricle. A time marker marks off usually one-fifth and one-twentyfifth of one second. The Cambridge instrument furnishes a double string carrier, one of which may be used to take the electrocardiogram, and the other depicts the curves of the normal heart sounds. When used with a microphone, which is supplied with this device, this apparatus gives beautiful simultaneous curves of heart beats and heart sounds in the hands of those who have time and the laboratory touch. The electrodes for patients commonly used today are curved zinc, or better, German silver plates, non-polarizable, covered with thick canton flannel, wet with hot twenty per cent. salt solution, and bound to the forearms and left leg. To these the wires leading to the instrument are connected. These wires may be of any length; with appropriate wiring the curves can be taken while the patient rests in bed in a distant building on the hospital grounds. Salt decreases resistance, the heat decreases muscular tremor. This type of electrode is so light and easily attached that it has come into general use. Ordinarily, it yields perfectly satisfactory curves. Where the patient's resistance is high and his muscular tremor marked, the immersion electrode, originally furnished with the Cambridge outfit, has much to commend it. For clinical purposes, the film camera is preferable for routine use. The bromide paper furnishes a satisfactory curve, requires but one step in development, and is a perfect record. When one wishes to reproduce a curve, the white line of the bromide paper is not as satisfactory as the black line that one secures in the film and plate curve. The film and plate curves are more time-consuming because they are first developed and later a print is made as in ordinary photography. The camera furnished with the Hindle machine affords a choice of film or paper by using a second removable box. The disadvantage of the plate camera is the limit placed on the length of curves one can take. Its advantage is that the plate furnishes a perfectly level surface on which the comparator may be used in making fine measurements. This is more im-

portant in experimental than in clinical work. By placing a moving lever attached to a tambour, such as used in the polygraph, in front of the camera, records of arterial or venous pulse, respiration, or even blood-pressure, may be obtained simultaneously with the electrocardiogram. This lever must be vertical and at right angles to the cylindrical lens fixed in the camera. Such a tambour yielding a simul-
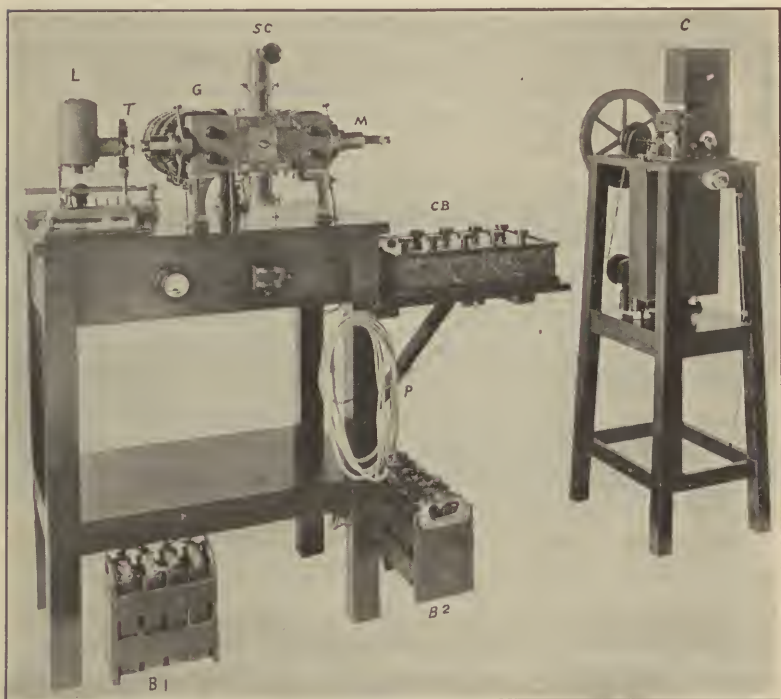
Fig. 5.—Hindle electrocardiograph, medium sized model. *L*, light; *T*, timer; *G*, galvanometer; *SC*, string carrier; *M*, microscope; *CB*, control board; *C*, camera; *B*1, timer battery; *B*2, galvanometer battery; *P*, wires leading to patient.

taneous arteriogram would detect alternation routinely, an abnormality that the electrocardiogram very often fails to show.

The two machines available today are the Hindle (Fig. 5), made in Ossining, N. Y., and the Cambridge, made by the Cambridge and Paul Instrument Company, Ltd., in London,

England. Both are reliable. Dr. H. B. Williams, to whom all workers on this subject in America owe so much, has given his advice freely in the construction of the Hindle machine. The comparative ease with which one can get help when things go wrong scores heavily in favor of the American made machine. It is not possible, nor perhaps desirable, here to go into the technique of the use of the instrument, as that has been more fully and better recorded elsewhere, and the large part of it can be learned only by actual work in the heart-station room, so with this introduction we may pass on to the leads adopted in securing and the interpretation of the normal electrocardiogram.

The Leads Adopted: I. Leads from the right arm to the left arm.

II. Leads from the right arm to the left leg.

III. Leads from the left arm to the left leg.

It should be understood that the minute electric current accompanying cardiac contraction can be led off from many points on the body, but for the sake of setting a standard, Einthoven chose these three leads, which are universally used. Three leads are used instead of one because each differs somewhat, and one may give information which is lacking in the other two. All three show normally systole of both auricle and ventricle.

The Normal Electrocardiogram. The normal electrocardiogram (Fig. 6) consists of several deflections called empirically: P, Q, R, S, T. The peak P is due to the activity of the two auricles. Normally, it is always found as a summit in all leads, rarely exceeds two scale divisions in height and may be bifurcated. Between P and the up stroke of R the string shadow either maintains a horizontal position or dips somewhat. The distance from the up stroke of P to the beginning of the ventricular complex, R or Q, represents the auricular complex. This period is called the P-R interval. Normally, its duration is from 0.13 to 0.18 second. In the normal heart it never exceeds 0.2 of one second. With auricular complexes of this form we know that the impulse has arisen in the natural site and has flowed through the auricular walls in a normal direction. The ventricular complex varies. R and T are practically always present; Q and S often absent.

Normally R is highest in Lead II. They all may vary in shape and altitude and T may vary in direction. In the normal electrocardiogram R and S are often notched. In Lead III the Q, R, S group often takes unusual forms, which may be neglected in interpretation. Normally, T is always upright in Lead II, is often inverted in Lead III, and may show partial inversion in Lead I. However, the high cardiac mortality in patients with inversion of T in Lead I, as shown by Willius,[28] should make one hesitate to pass over partial inversion in Lead I as of no importance. T is often increased in amplitude by exercise, flattened with age, and flattened or even inverted by digitalis. Closely following T in early
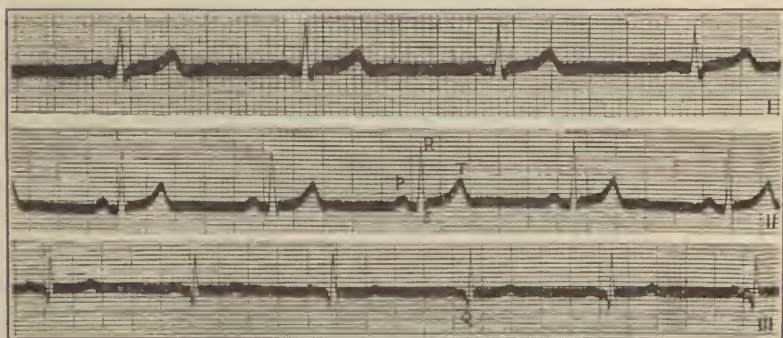
Fig. 6.—Electrocardiogram from the three leads of a normal person, showing the auricular summit (P), and the ventricular deflections (Q, R, S and T). The vertical lines ⅕ and ½₅ seconds. The distance between the horizontal lines represents ⅒ of a millivolt.

diastole there is often a small positive wave called U, whose meaning is not understood. The time occupied by the Q, R, S, T group is approximately the time of the particular ventricular systole in which they are born. The earliest sign of ventricular activity coincides with the up stroke of R or Q. These deflections are due not to contraction of the muscle but to the excitation wave immediately preceding contraction. The time distance from the upstroke of R or Q to the point where T passes into the horizontal line of diastole represents the length of ventricular systole. This horizontal line in diastole is the same as the more or less horizontal line between the end of P and the up stroke of R, and be-

tween the down stroke of R and the up stroke of T. It is called the zero or iso-electric line. The iso-electric line represents a time when no currents are passing. It may be absent before T and may disappear in diastole where the heart rate is very rapid, especially if prolonged conduction is associated with the tachycardia. In electrocardiography deflections above this line are spoken of as positive, whereas dips below the line are called minus. The Q, R, S group in normal individuals has a total duration of one-tenth of one second. With the presence of the Q, R, S, T group of physiologic form, it is known that the ventricular contraction is in answer to an impulse which has flowed through the A-V bundle, its main divisions and arborizations. The meaning of the individual ventricular deflections in the electrocardiogram is known up to a certain point; it serves no clinical purpose to go into it here; suffice it to say that Q is now known to be a ventricular event. However, there are certain general statements, derived both from experiment and clinical work, which are of paramount importance in this study. It is known that if the excitation wave follows an abnormal course in the heart, it will yield an abnormal electrocardiogram. The latter always means either ectopic origin or abnormal distribution of the impulse wave. This means that if we should alter the ordinary leads from the body, the electric curves would alter.

Any heart yielding curves showing a decided deviation from the physiologic form is abnormal. The reverse statement does not hold. A normal electrocardiogram does not necessarily mean a normal heart. The form of the electrocardiogram in a given individual, taken at different times under similar conditions, shows a remarkable constancy in health. So characteristic are they that the electrocardiogram has been proposed to take its place beside the finger print as a means of identification.

ABNORMAL MYOCARDIAL FUNCTION.

Branch Bundle Block.

With the normal electrocardiogram in mind we pass to the abnormal forms. We will take up first of all branch

bundle block, an evidence of myocardial impairment, revealed alone by electric methods. These abnormal curves also give us an insight into the method of formation of the normal electrocardiogram. By a supraventricular impulse is meant one arising above the bifurcation of the bundle. Such an impulse, if distributed normally by the intraventricular conduction system, yields a physiological
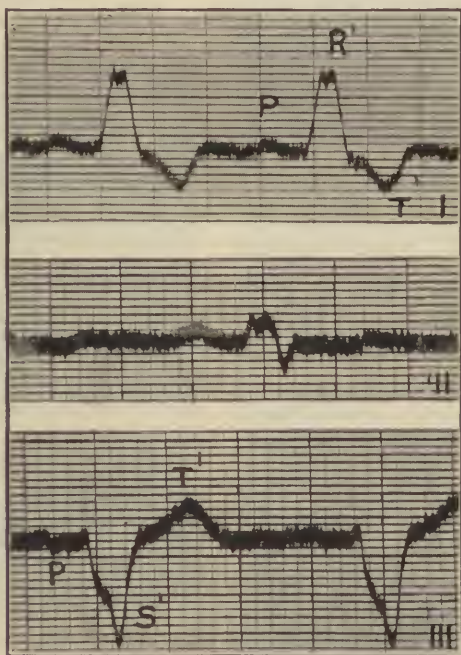
Fig. 7.—Curves from the three leads showing conduction defects of the right division of the A-V bundle. Note the great width and height of R' in Lead I, and the depth and width of S' in Lead III.

electrocardiogram, but where a supraventricular impulse is distributed in a faulty manner in the ventricles, an abnormal electrocardiogram will result. This abnormal process is called *aberrancy* and there is no more striking example of aberrancy than the curves of branch bundle block, for just as conduction may be abolished or depressed in the main stem, so it may be in the right and left main divisions. Fig. 7 shows the curves in the three leads, where the right main

branch of the auriculo-ventricular bundle is defective. An auricular complex precedes each ventricular beat. Note the broad summit R' in Lead I and the broad deep S' in Lead III. Note also that the R' and S' deflections, which replace the usual Q, R, S group, have a total duration of more than one-tenth of one second and occupy more than one-third of the
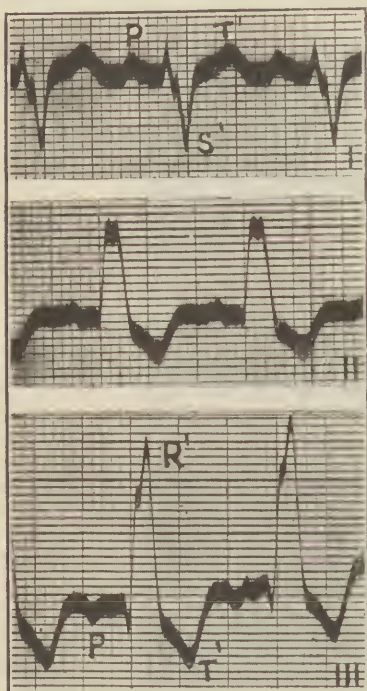
Fig. 8.
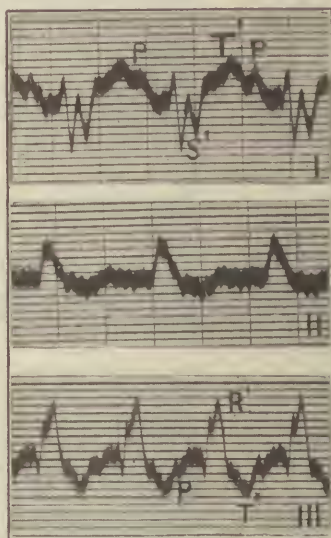
Fig. 9.

Figs. 8 and 9.—Curves from the three leads showing conduction defects of the left division of the A-V bundle. The directions of the deflections in Leads I and III are the reverse of those in Fig. 7. Note the peculiar splitting of S' in Lead I of Fig. 9.

whole ventricular complex. The ascending or descending limb or apex of R' and S' are usually notched, the large T' is of opposite sign to the first main deflection in the same lead. Thus in Lead I the depressed T' contrasts with the upright R'. In Lead III the upright T' is of opposite sign to deep S'. Figs. 8 and 9 show the curves in the three leads

in a patient showing functional defect of the left division of the A-V bundle. The initial deflections in Leads I and III are in the reverse direction to those in Fig. 7. There is a deep S' in Lead I followed by a prominent positive T'. In Lead III there is a tall wide R' followed by a negative T'. These curves from their exaggerated height and width immediately attract attention. They can be confounded only with the curves of profound preponderance showing an unusually wide R or S. In such a case the fact that T' is of opposite sign to the main events in Leads I and III fixes it as a defect of the bundle. In extreme cases of preponderance the T deflection usually takes the same direction as the main event R or S in Leads I and III. The curves of Lead II, in lesions of the right branch, are often similar to those of Lead III, but this is not uniform. Leads I and III are relied upon in diagnosis. Bizarre events in Lead II are confirmatory. The proof that these unusual curves are due to defective conduction along the right and left main branches of the bundle is afforded by experiment. The experimental curves in monkeys furnish exactly the same picture because in the monkey's heart the intraventricular conducting system is the same as in the human heart. Section of the right branch below the bifurcation causes a supraventricular complex to be distributed to the left ventricle along the left main branch in a normal manner. The right ventricle, on the contrary, receives its excitation wave by a cross spread from the normally excited left ventricle. Naturally the excitation wave spreads more quickly by the normal left branch so that the action currents of the left ventricle predominate. Here the Q, R, S group of initial deflections is largely a left ventricular event and the combined curves of Leads I and III are referred to as the levo-cardiogram. When the left main branch is sectioned the impulse spreads normally along the right branch to the right ventricle, and the left ventricle in turn receives its stimulus to contraction in an abnormal manner. Here the activities of the right ventricle predominate in the curves and the combined curves of Leads I and III are called the dextro-cardiogram. Thus we see that each ventricle, supplied as it is by its own conducting system, by way of the right and left branches, contains its own cur-

rents of activity and it is the algebraic sum of these curves which constitutes the physiologic electrocardiogram, also called in experiment, bicardiogram. Thus we see the normal electrocardiogram is a composite picture. This receives added proof from the fact that if the levo-cardiogram and the dextro-cardiogram are superimposed so that the events occurring at a given instant rest upon a vertical line and the algebraic sum of Q, R and S in Leads I and III are taken, it will yield a picture of the normal electrocardiogram.[29]

The Clinical Aspects of Branch Bundle Block. This condition is not infrequent among patients as a permanent condition and perhaps we shall find, as we gather statistics, that it is not rare as a transient condition. Its presence speaks for myocardial disease in the region of the particular branch affected, which is but a local expression of a more widespread disease process. Vascular degeneration of the obliterative type and fibrosis are the pathologic changes found. Among the cases seen, old syphilis, a history of rheumatic fever, and more often generalized arteriosclerosis, unprovoked by any such definite infections, were present. The patients showed a restricted field of cardiac response to unusual effort, and they fatigued easily, even by ordinary physical and mental effort. A few suffered from true angina pectoris, others from indefinite distress on exertion. Willius[30] found these abnormal Q, R, S complexes in all derivations of the electrocardiogram in fourteen per cent. of one hundred and fifty-five cases of angina pectoris studied. The cardiac mortality in his complete group was forty-seven per cent., but of those showing branch bundle block in all three derivations of the electrocardiogram the mortality was sixty-two and one-half per cent. There is a high mortality in these cases, with or without pain. The sole physical sign is a reduplicated first sound, which is often absent. Absolute diagnosis is by electrocardiogram only. Though branch bundle block more often occurs where the auricular mechanism is regular, one occasionally sees it in auricular fibrillation, and I have recently seen it in a heart which beginning with A-V rhythm years ago, finally passed to complete dissociation with auricular flutter. (Fig. 39.) From this patient, under the simple effort of standing erect, we

secured curves of right branch bundle block and of left branch bundle block alternately within an hour. These curves will be published elsewhere, as the patient is still under observation. Clinically, as well as experimentally, the picture of branch bundle block may then be due to permanent or transient obstruction of conduction in the main branches. There is an incomplete branch bundle block. Theoretically this may be due to a difference in the route or rate of impulse in the two branches. Transient functional defect of the right branch of the bundle was found in a patient by Lewis[31]; transient defect of the left branch of the bundle by Mathewson.[32] The latter has also reported curves from a patient showing transient obstruction occurring alternately in the two branches of the bundle. Wilson[33] was able to produce the curves of branch bundle block in one patient by vagal pressure. In conjunction with Herman,[34] he has recently reported some interesting experimental work on the subject. Left branch bundle block is clinically extremely rare, while defect in the right branch is comparatively common. The frequency of right branch involvement may be due to the fact that it runs a longer course as a single band, and thus is more easily involved. The left branch subdivides early and a widespread lesion would be necessary to involve all its branches. Defect of the right branch is frequently associated with aortic disease. This unexpected finding remains unexplained.

Ventricular Preponderance.

In aortic disease and in mitral obstruction, Einthoven found curves which he looked upon as characteristic of left and right ventricular preponderance respectively. Fig. 10 represents the average curves from three leads in a case of aortic disease. These are the curves of so-called left ventricular preponderance. They are diagnosed from Leads I and III. Note the tall upright R in Lead I; the deep S in Lead III; and that the T in both leads follows the direction of the main deflection. Fig. 11 are the curves of right ventricular preponderance found in some cases of mitral and pulmonary obstruction. Note the deep S in

Lead I and the tall R in Lead III. These curves bear a striking resemblance to the curves of right and left branch bundle block respectively. They are differentiated thus: In preponderance the width of the initial deflection R or S rarely exceeds one-tenth of one second; in branch bundle block it always does. In preponderance the T deflection more often takes the same direction as the R or S in Leads I and III; in branch bundle block it is always opposite in direction to
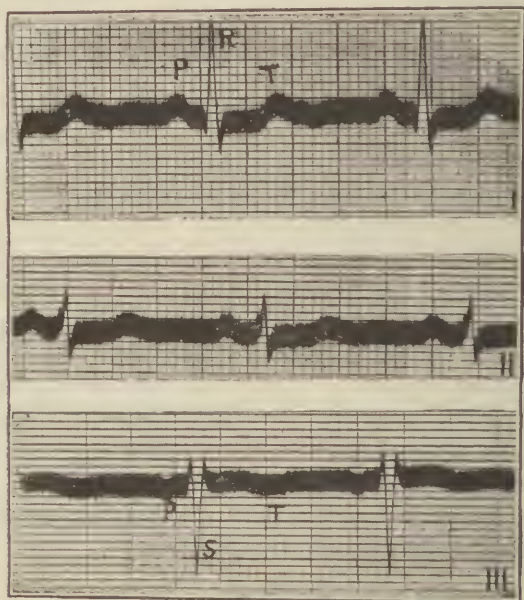
Fig. 10.—Curves from the three leads in a patient with aortic disease showing preponderance of the left ventricle. Contrast the tall R in Lead I with the deep S in Lead III.

the main initial deflection in Leads I and III. In those cases of extreme preponderance where the initial deflection R or S does exceed one-tenth of one second the diagnosis between preponderance and branch bundle block rests upon the direction of T alone. The R' and S' are practically always splintered in branch bundle block; less commonly in preponderance. Left preponderance is commonly associated with aortic disease and cases of high blood-pressure, as in contracted kidney and essential hypertension. Right pre-

ponderance is commonly associated with advanced cases of mitral stenosis and pulmonary obstruction.

Einthoven formerly referred to these curves as the curves of hypertrophy. Lewis[35] suggested that preponderance would be a better term, for when we speak of hypertrophy of the heart we usually picture an enlarged heart, whereas the diseased heart showing these curves may be normal in
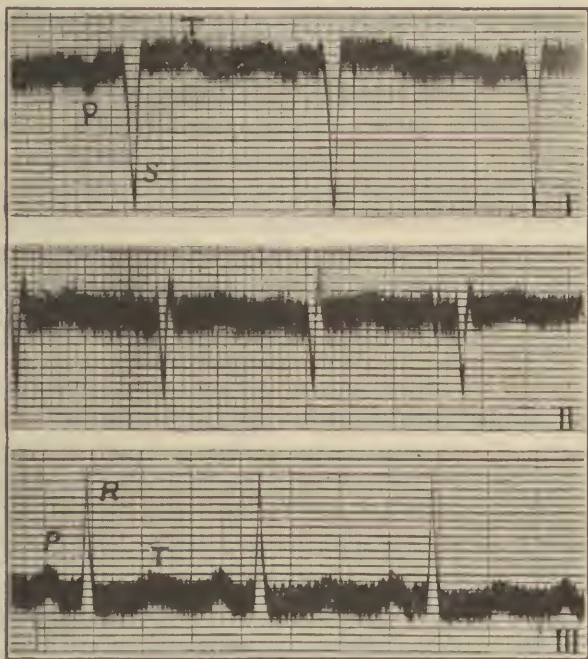
Fig. 11.—Curves from the three leads showing preponderance of the right ventricle. Contrast the deep S in Lead I with the tall R in Lead III. Note the ectopic P in Lead I.

size. In a normal heart, when the ventricles are separated and weighed, the left ventricular weight is from one and six-tenths to two times the weight of the right ventricle, whereas in the hearts under discussion there is a disturbance of this muscular balance. The increase in the muscle mass of the left ventricle or the right ventricle impresses upon these electrocardiograms the predominance of the levo-cardiogram or the dextro-cardiogram, as the case may be. It does this

because with the increase in muscle mass, the excitation wave takes a longer time to traverse that particularly thick ventricular wall, also because it deflects the angle at which the heart lies in the body and both factors tend to modify the electrocardiogram. Though on the average the curves one would expect to find with a given valve lesion are present, this is not always true. Sometimes, in aortic disease, one finds curves of right sided preponderance. In such a case Lewis suggests that both ventricles are hypertrophied and in this case the right even more so than the left. The same is held to be the explanation where expecting to find right sided hypertrophy, curves of left preponderance appear. It is interesting to note that in a new-born infant the weight of the right ventricle is relatively much increased, so that the heart gives the curves of right ventricular preponderance. About the third month after birth the normal proportion between the right and left ventricle obtains and the electric curves take their normal form. Krumbhaar and Jenks[36] made an interesting report on this subject.

Einthoven drew attention to the fact that changes in the position of the heart in the chest led to changes in the electrocardiograms. Normally, the heart lies at a given angle with a perpendicular line let fall through its center. Changes in this angle are caused by respiration, that is, with rise and fall of the diaphragm, by ballooning upward of the diaphragm with collection of gas in the stomach, by right sided or left sided decubitus, and by increase in the mass of right or left ventricle. By studying the rotation of the electrical axis of the heart, Einthoven and many workers have found a basis for a better understanding of the normal electrocardiogram and the curves of preponderance, and furthermore from this study have derived a means of rapid quantitative estimation of the amount of hypertrophy in a given ventricle, at least as far as it can be shown by individual curves of preponderance. The explanation of the method is abstruse to the average reader, but its practical application in the heart station is simple. With the formula of White and Bock[37] and with a photostatic enlargement of the diagram furnished in the paper of Carter, Richter and Greene,[38] one can examine the preponderance curves in a few minutes and assess

the change in the ventricle. Those interested in the subject
will find it developed in Lewis's Mechanism and in the arti-
cles by Carter, Richter and Greene, Dieuiade,[39] and Pardee.[40]
The latter finds that all the formulas for estimating ventric-
ular preponderance hold true only in a general way.

Again, although the electrical axis is not synonymous with
the anatomical axis, the former may be taken roughly to
represent the latter, so that the abnormal position of the
heart in the body is suggested by certain changes in the
electrocardiogram. In dextrocardia, the heart makes about
the same angle to the right of the perpendicular as it does
normally to the left. In dextrocardia all the deflections in
Lead I are inverted. Leads II and III remain practically nor-
mal. The electrocardiogram is one of the surest signs we
have in the diagnosis of dextrocardia. On the other hand,
a heart displaced to the right by large pleural effusion, by
the collapse of one lung, whether by spontaneous or induced
pneumothorax, usually shows no change in the electrocardio-
gram, for the reason that the whole heart is pushed to the
right and its electrical axis is apparently more or less un-
disturbed. There is one type of patient where the curves of
hypertrophy have seemed to me to be of a special help. It
is the patient who comes showing only a systolic murmur
at the apex and probably with a history of some infection
earlier. The physician and the patient wish to know defi-
nitely whether or not this individual has heart disease. In
such patients the presence in their curves of auricular hyper-
trophy and right sided preponderance seem to point to def-
inite structural changes in the heart. The interval between
the suspected infection and the demonstration of the curves
of preponderance is not always long.

Bradycardia.

True bradycardia is that form of slow pulse where
auricle and ventricle follow each other with normal se-
quence. Again it may be emphasized that the rate of the
heart is accurate only if taken at the apex. Rates of from
fifty to sixty are not uncommon in normal individuals, espe-
cially in the aged. Occasionally in a true bradycardia, the

pulse rate is as low as forty, but this is rare. Bradycardia may be found in convalescence after typhoid, influenza, pneumonia, and diphtheria. It occurs in jaundice, diabetes, uremia, hypothyroidism, and during the administration of digitalis and opium. It is found in meningitis, in cerebral hemorrhage and tumor, sometimes in epilepsy, in hypertension, in aortic stenosis, in chronic nephritis, in pregnancy, and in vomiting. Thus it is caused by a direct depression of the sino-auricular node, by poison, or by increased vagal tone, either centric or reflex. In arterial curves, the regular *a, c, v* wave will be found. In electrocardiographic curves, this slow rhythm is regular and shows normal *P, R, T* deflections. Sometimes where the rate is particularly slow, the ventricle escapes, acting in response, not to the slow on-coming auricular impulse, but to a new one arising in the node. Thus, for a time, we may have a nodal rhythm. The *treatment* of bradycardia is the treatment of the associated conditions.

Heart Block.

In a normal rhythm of the heart, we learned that the auricular impulse originated in the sino-auricular node, and was distributed to the ventricles by means of the *A-V* conducting system. In heart block, the function of the conducting system is impaired or abolished, so that the auricular stimulus activates the ventricle late or fails entirely to incite a ventricular response; thus we have partial and complete heart block. Also, heart block may be temporary or permanent. The diseases with which heart block is associated are, first of all, rheumatic fever, then diphtheria, influenza, typhoid, pneumonia, scarlet fever and infections by virulent pus organisms. In moribund cases in certain acute infections, asphyxia has seemed to play a rôle also. The rebreathing of air deficient in oxygen, in experiment, was found capable of producing even complete heart block in aviators. and it is suspected that this changed mechanism of the heart may be responsible for some of the discomforts and accidents at high elevations, experienced by aviators, balloonists, and even mountain climbers.[41]   Ordinarily, in the acute infections simple prolongation of conduction is more common and the normal mechanism of the heart returns with convales-

cence. Chronic heart block is commonly associated with two diseases: with severe or repeated attacks of rheumatic fever, or with syphilis. The latter may appear in the form of gumma, ulceration, or by direct invasion of the cardiac vessels and muscle tissues. Endothelioma, sarcoma, and fibroma, have been reported as causing heart block.

The special tissues affected in heart block by all of these disease processes are the *A-V* node and the *A-V* bundle, but commonly the process is not limited to these special structures. Their impairment is but a local expression of widespread myocardial involvement due to the morbid process. In acute and subacute cases of heart block, parenchymatous degeneration or acute inflammation, with leucocytic infiltration, is found. In the chronic forms, chronic inflammation, degeneration, fibrosis, and calcification, may be widespread. Rarely the local effect may be solely due to tumors, gumma and ulceration. Heart block is commoner in men than it is in women and may occur at any age. Congenital heart block has been reported and in the arteriosclerotic disintegration of the heart in old age, heart block is not uncommon. As it is especially common among those who have suffered from rheumatic fever and chorea, it has the same incidence, that is, from ten to forty years. The relations of digitalis to heart block are important. Digitalis may prolong conduction in the normal heart. In a heart already showing prolongation of conduction digitalis may increase block up to complete dissociation. The same is said to be true of strophanthus and squills. This action of digitalis, which results in slowing of the pulse, is due to two factors: First, its direct action upon the junctional tissues—Lewis finds it increases the refractory period of the *A-V* node— and secondly, its action through the vagus. The latter influence may be removed by a hypodermatic injection of one-fiftieth of a grain of atropin sulphate. In this connection it is interesting to recall what has been said about the influence of the right and left vagus (page 206). Vagal pressure has been used recently in diagnosis and in treatment. This nerve runs in the sheath of the carotid artery; and obliterating the artery with the thumb, pushing the vessel directly back against the underlying bony structure makes direct

pressure upon the vagus. It has been found that pressure thus exerted can produce prolongation of the P-R interval in a healthy individual; also where prolonged conduction already exists, vagal pressure may increase the grade of heart block even to complete heart block. In delayed conduction as a result of previous rheumatic fever, Mackenzie demonstrated that the simple reflex action of swallowing could increase prolongation of conduction even to dropped beats; this is a
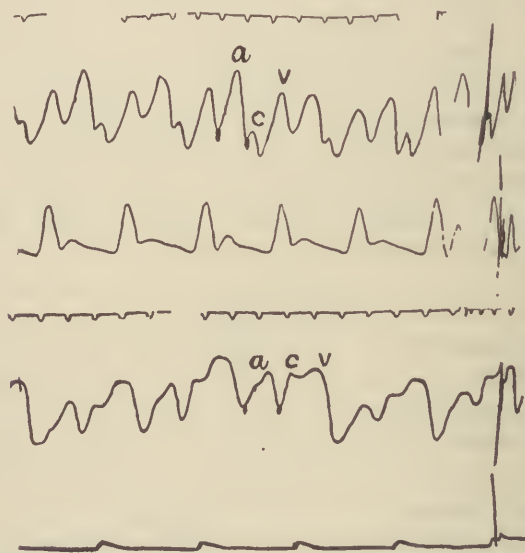
Fig. 12.—Two polygraph curves showing prolongation of the *a-c* interval.

vagal influence as well as that of the so-called oculocardiac reflex, in which slowing of the heart may be induced by pressure on the eyeball. Direct pressure on the vagus in the neck and the oculocardiac reflex have been used as a means of abolishing an attack of paroxysmal tachycardia and slowing the ventricle in auricular flutter. Chronic heart block due to vagal influence alone probably does not exist clinically. If it did exist we should find a group present in which atropine would abolish the block. It has been known to reduce the degree or abolish the block only where the latter was due to the administration of digitalis and its allies.

Atropine usually is without effect on the ventricular rate in complete block.

To sum up, according to Lewis's[42] view, the vagus may produce temporary block, it may increase the degree of pre-existing block, it may cause continued block, when the vagal mechanism is stimulated by drugs, but it has not been shown that persistent heart block of high grade is due to this cause.

The Grades of Block and Their Recognition. The electro-cardiograph reveals block with great precision. Next in usefulness is the polygraphic curve. We shall also try to show that by concentrating the attention upon physical signs one can make a fairly definite diagnosis.
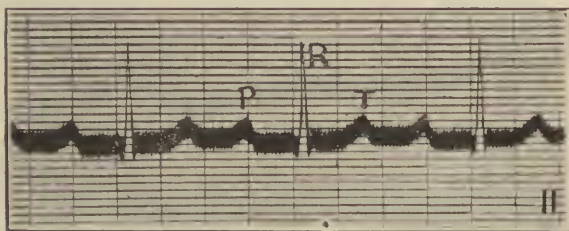
Fig. 13.—Simple prolongation of the *P-R* interval
in an electrocardiogram.

Prolongation of the As-Vs Interval. By the *As-Vs* interval in curves is meant the time distance from the beginning of auricular systole to the beginning of ventricular systole. This term is used because it includes both the P-R interval of the electrocardiogram and the *a-c* interval of the venous curve. The normal *P-R* interval is from twelve-hundredths to eighteen-hundredths of one second. The normal interval varies between one-tenth and two-tenths of one second. In the first stage of heart block, known as prolonged conduction, these intervals are much longer. (Figs. 12 and 13.) In Thayer's[43] case of marked bradycardia with Adams-Stokes's syndrome, the *P-R* interval was increased to at least seven-tenths of one second and the *a-c* interval to practically a full second. These are unusual prolongations. Ordinarily five-tenths of one second is considered extreme. Where the heart rate is rapid or prolongation of the *As-Vs* interval great and the heart rate normal, the auricular sys-

tole may fall back upon the preceding ventricular systole,
Fig. 14. Where a single T or a series of T's in an electro-
cardiogram show notching, it is usually the result of this
mechanism. Simple defect of conduction can rarely be diag-
nosed by ordinary clinical means. However, when the au-
ricular and ventricular systoles are sufficiently separated, it
is said an acute ear may distinguish the auricular sounds;
also with a slight increase of the As-Vs interval, the first
heart sound may be reduplicated. With greatly prolonged
conduction there may be a double second sound, for the au-
ricular systole will then fall in early diastole. In mitral
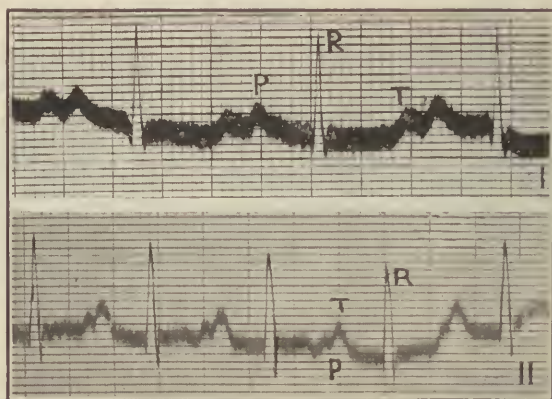
Fig. 14.—Two electrocardiographic curves. The prolonged P-R in-
terval causes P to fall with the preceding systole, thus notching T.

stenosis, the murmur and thrill are coincident with auricular
contraction. In this heart lesion, prolonged conduction is
common, so that contraction of the auricle in the presence
of block is apt to occur in mid diastole or earlier, with its
concomitant diastolic rumble. However, these early or mid-
diastolic murmurs of old mitral stenosis are common and
only a small proportion of them shows definite signs of heart
block.

Dropped Beats. The next grade of heart block is the single
dropped beat. (Fig. 15.) An intermission is found at the
wrist, but on examining the apex we find not the abortive
effort of extra systole but a complete silence. The auricle
has failed to stimulate the ventricle, which remains quiescent

during the time of one beat; the length of the pause may be equivalent to two rhythmic beats, but this is unusual. It is commonly shorter because it is associated with variations in the lengths of the *As-Vs* intervals before and after the abnormal event. The dropped beat is usually signalled by a progressive increase of the preceding *As-Vs* intervals, and furthermore the interval following the dropped beat is
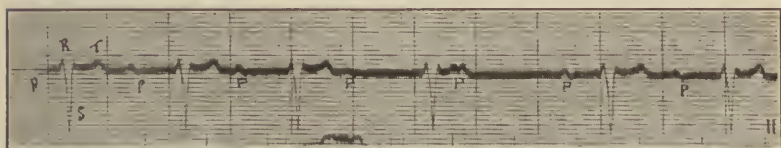
Fig. 15.—Partial heart block. Note progressive prolongation of *P-R* interval. There is a single dropped beat after the fourth ventricular complex.

usually shortened, both of which events shorten the long pause and lessen the disturbance of ventricular rhythm. Occasionally, cases have been reported of dropped beats without these variations of the *As-Vs* intervals. Also, suddenly developed complete heart block without preceding minor grades is recorded. In these cases complete block has developed later and changes have been found in the bundle.
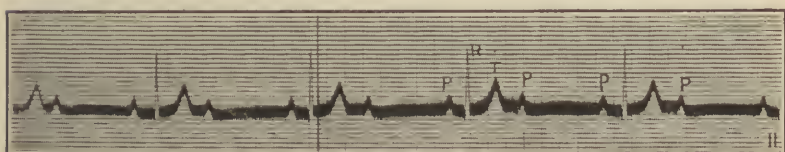
Fig. 16.—Two to one heart block, two auricular beats to each ventricular beat. The patient showed prolonged conduction, two to one block and intervals of complete block before the latter became persistent. The patient suffered from marked Adams-Stokes' syndrome.

In some reported cases of well developed heart block, even complete dissociation, satisfactory gross or minute lesions of the *A-V* node or bundle have not been found. When one considers the thousands of sections that must be studied, even though the node and main bundle alone are examined serially, one should attribute the lack of findings to our his-

tologic limitations especially in the face of experimental evidence. The single dropped beat is suggested in ordinary clinical examination by the ventricular silence at the apex and the reaction of the heart to exercise. Under exercise the pulse accelerates and becomes regular. With rest the irregularity reappears and the first evidence of its return is a long ventricular silence. This is in contrast to what happens in the irregular pulse due to premature beats or extrasystolic arrhythmia. In these exercise will also abolish the arrhythmia and with rest it will return, but the first evidence of its return will be a premature beat. A whiff of amyl nitrite has the same effect as exercise in making these tests. It also increases the heart rate and blood flow. It may be used
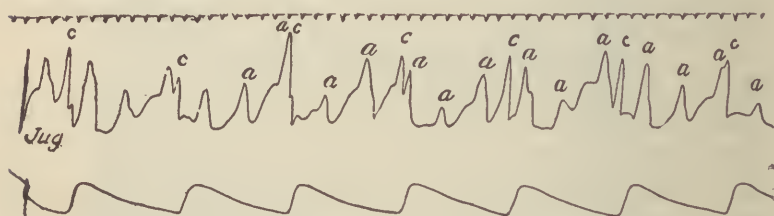
Fig. 17.—Radial and jugular curves from a patient with two to one and three to one heart block.

where one is examining a large number of subjects or where for any reason the exercise is not welcomed.

Higher Grades of Heart Block. With repeated and frequent failures of the ventricle to respond to auricular stimulation, a simple ratio between auricular and ventricular contractions arises. The commonest is 2:1 heart block, where the auricles beat twice as frequently as the ventricles. (Fig. 16.) In clinical curves, the auricular contraction immediately following the ventricular may be premature. Ordinarily, the auricular rhythm is undisturbed in partial block and the above observation is important for those studying clinical curves. The 3:1 and 4:1 ratio are seen in clinical curves but they are rare. The 2:1 or 2:1 and 3:1 cycles alternating are more common. Figs. 17 and 18 illustrate this point. They were taken from a patient under the care of my colleagues at the Presbyterian Hospital, Drs. Joseph Sailer and Francis

O. Allen. Clinically, 2:1 heart block is suggested where a regular ventricular rate lies between forty and fifty to the minute. Exercise or a few whiffs of nitrite of amyl at once doubles the ventricular rate. With rest, this increased rate abruptly halves. A sudden and exact halving of a ventricular rate, or an exact doubling, is always suggestive of two-to-one block, as it is an unstable condition. When each third or fourth ventricular beat is missing, this irregularity, like the single dropped beat, may be recognized by its reaction to exercise, for the arrhythmia disappears with increased heart rate and its return after rest is marked by a ventricular
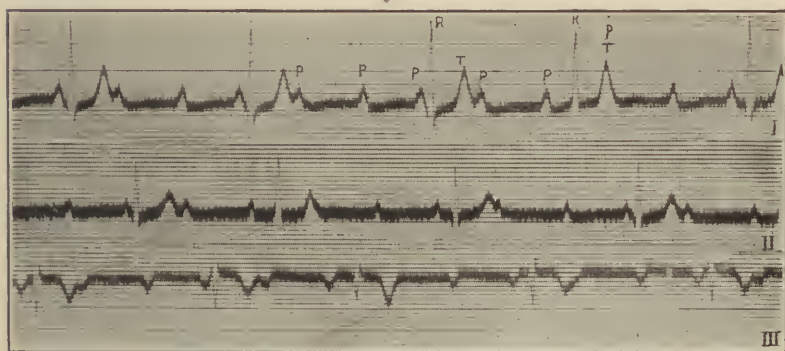
Fig. 18.—Two to one and three to one heart block. Pulse rate, 36 Left preponderance. From the same patient as the arterial curves in Fig.17. Patient had the Adams-Stokes' syndrome.

silence. In mitral stenosis with two-to-one heart block two diastolic murmurs may be heard to each ventricular systole, since the thrill and the crescendo murmur of mitral stenosis are generally considered to be due to auricular systole and as the auricle contracts twice to the ventricle's once, they should double in number.

Complete Heart Block. The maximum grade of heart block is reached when the *A-V* conducting system fails to transmit any auricular impulse at all. In this case the ventricle beats in response to a new center of impulse formation situated in the upper reaches of the *A-V* bundle. This form of block is also called dissociation and shows two distinct rhythms, the auricular, which begins in the natural pace-

maker, and incites the auricular contractions which are regular and commonly at a rate of between seventy and eighty per minute; and a regular ventricular rhythm at a rate of about thirty. The two rhythms are quite independent and the deflections in the electrocardiogram due to auricular and ventricular activities fall with varying relations to each other as seen in Fig. 19. The two rhythms are ordinarily quite regular. This does not hold good in all clinical examples, as those having to interpret curves should remember. Wilson and Robinson[44] have pointed out that the interauricular period, during which the ventricular systole falls, is shorter than those which follow. (Fig. 16.) This was referred to
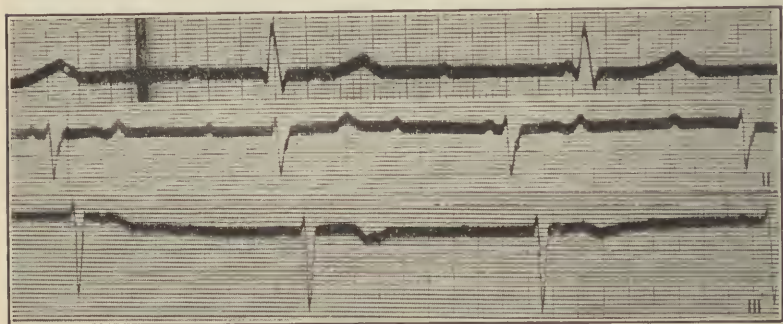
Fig. 19.—A curve of complete heart block, the auricles and ventricles beat regularly but at independent rates of ninety and forty.

in two-to-one heart block. We will simply note the fact here and not try to go into explanations. The recognition of complete heart block at the bedside may be suspected where the ventricle is beating regularly and at thirty-five or under, also where this rate is practically undisturbed by exercise, by amyl nitrite or by atropine. In the neck the slow beat of the carotid may be observed and the oscillations in the jugular due to the more rapid auricular contraction may be seen. Occasionally a large venous pulsation is evident, which means that the auricular and ventricular systoles have fallen together. (Fig. 17.) At the apex one recognizes the first and second sound with each ventricular beat. The faint sounds due to auricular activity may be heard during the long diastole. Changing heart sounds are suggestive; simul-

taneous auricular and ventricular contractions intensify the first sound. When they fall almost together, the first or second sound may be reduplicated.

Symptomatology of Heart Block. The symptomatology of heart block depends not upon block alone but upon the condition of the whole heart muscle and, if present, the extent of valve involvement. Simple prolonged conduction, which is the first evidence we have of impaired cardiac function, often exists in individuals with apparently normal hearts. Where the patient has had a previous attack of rheumatic fever, it may be revealed unexpectedly in a tracing. Furthermore, its presence is to be suspected wherever, in such hearts, digitalis quickly produces high grades of block. Young individuals and even those of more mature years with a healthy ventricle may have complete dissociation and yet lead comfortable lives. With complete dissociation a heart sufficiently healthy to react develops a certain amount of ventricular hypertrophy which seems to compensate for the disturbed mechanism. In a case where the slow beating ventricle is regular or shows but an occasional premature beat, and where there is a fairly high systolic pressure and a comparatively low diastolic pressure, and the field of response to effort fairly good, the outlook is promising. The prolonged diastole allows the arterioles to empty thoroughly into the veins from which the low diastolic pressure arises. The unusually well filled venous side of the heart supplies the left ventricle with a large amount of blood, which gives rise to a strong systolic output with high systolic pressure.

However, from the irregular or the slow rate and incompetent myocardium, in a certain number of cases, the systolic output is insufficient for the systemic demands, and the brain is the first witness of this deficiency. Under these conditions arises what is known as the Adams-Stokes syndrome. Heart block and the Adams-Stokes syndrome are not synonymous. The majority of cases with high-grade block never suffer from these symptoms in their entirety. The Adams-Stokes syndrome is characterized by a sudden marked slowing of the usual pulse rate of the individual, accompanied by attacks of unconsciousness with or without convulsions. The cause of the seizures, whether they be confined to uncon-

sciousness or also accompanied by fits, is due to cerebral
anemia, the result of abrupt slowing of the ventricular rate.
These attacks may be mild or severe; mild attacks are char-
acterized by vertigo, faintness, pallor, loss of consciousness
and absence of ventricular beat. Severe seizures arise when
the ventricular standstill lasts twelve seconds or more. Here
venous engorgements cause pallor to give way to cyanosis,
to unconsciousness is added twitching of the face or of an
arm and occasionally the fits become generalized. In these
attacks the patients do not pass urine or bite the tongue.
In the mild cases, breathing may be normal; in severe at-
tacks, stertorous and apneic. The only suggestion of an aura
is that at times the patient becomes aware of the sudden
slowing of ventricular rate. A single period of ventricular
standstill of about five seconds will usually cause uncon-
sciousness; with asystoles of from fifteen to twenty seconds,
convulsions are added. Among our cases, as is usual, the
critical time has been when there was a tendency to pass
from partial block to higher grades and to complete dis-
sociation. Patients have started from home with an apex
rate of thirty, entered the hospital with the same rate, but
by the time a curve was taken, the rate was sixty and the
only abnormality was a slight prolongation of conduction.
I have kept such patients under observation for a week, al-
lowing them to be up and walking about, but the same minor
abnormality persisted. After returning home, it was always
some unexpected physical exercise which precipitated the
new attack. One patient under observation for two and one-
half years has shown repeatedly prolonged conduction, once
two-to-one block and recently complete dissociation. We
know that this man has passed through prolonged conduc-
tion, two-to-one block, complete dissociation, and in the re-
verse order many times during the two years, because I have
seen him, and his doctor has reported at various times pulse
rates of eighty, sixty, forty, and thirty. It was during the
time when the rates were thus intermingling that the patient
was confined to bed during periods of from one to three
months at a time, and his life often imperilled. Since the
establishment of complete block, which appears to be per-
sistent, he is much better. This is the usual history.

Prognosis. Heart block itself does not directly cause death. The majority of the patients die with the ordinary signs of cardiac failure. In making this statement, we must bear in mind that heart block and the Adams-Stokes syndrome are not synonymous terms. The earlier grades of block, prolonged conduction and dropped beats, are found after acute infections, especially rheumatic fever. Ordinarily, this sign of myocardial involvement disappears during convalescence. Where this temporary block becomes persistent, the outlook is more serious. Commonly, it is but an expression of a more widespread invasion of the heart muscle and is often found where there are also valvular lesions, especially mitral stenosis. The higher grades of block leading to complete dissociation are more grave because they show a more decided and permanent interference with the cardiac function, also because in the higher grades of block the mechanism is unstable. It is during this changing mechanism that the patient is in greatest danger. When the block becomes complete and remains complete the patient's condition is much safer. Both in the higher grades of incomplete block and in dissociation, the uncertain element is whether the patient will develop syncope and fits at all, and what their severity will be. The majority of patients with heart block never have the Adams-Stokes syndrome. In the changing mechanism of the high grades it is easy to see how temporary cerebral anemia may arise, and this is the basis of the fits. Just why in patients with complete dissociation with the usual ventricular rate of about thirty there should be in certain cases the sudden fall to 20-12-8, and in two cases seen, four ventricular beats per minute, we do not know. However, in these cases the myocardial disease is persistent, progressive and probably extreme, which but il· lustrates that in complete dissociation the welfare of the patient depends upon the condition of the ventricle.

Treatment. When the presence of block is found, it suggests at once the necessity of searching out the causative factors. In middle life, especially, syphilis should be excluded and even where the Wassermann is negative and the history suggestive, the patient should at least have the benefit of a course of mixed treatment. In the absence of syph-

ilis, a careful history of infections in the past and the exclusion of present foci of infection should be sought. As has been said, the milder grades of heart block in rheumatic hearts often disappear with convalescence. Where the condition tends to persist with or without evidence of endocardial trouble the period in bed should be prolonged. But where after a prolonged period in bed the signs of block persist but there is no other evidence of cardiac insufficiency, these patients may be allowed to be around, but should be kept under observation.

In patients with high grades of block, who show any tendency to fainting spells, the danger is greater because these patients may injure themselves in a fall. Without alarming them, they should be advised to go attended and not to undertake work which would be extra hazardous for them. Ordinarily, single fits do not kill; some patients succumb after a series of repeated convulsions; more die of progressive heart failure. With the onset of fits, especially during the changing mechanism, there is nothing comparable to prolonged rest in bed. As to the treatment of the convulsion itself, there is no specific. An injection of one-fiftieth of one grain of atropin may be given, and if it accelerates the pulse rate within one-half hour, one may feel sure that vagal action has been one element in slowing of the pulse. In such a patient one-hundredth of one grain of atropin three times in twenty-four hours may be continued unless its physiologic action becomes too marked. While there is little reason for believing that any drugs have much influence in increasing the pulse rate, which in turn relieves the unconscious patient, still one can not sit with folded hands. The use of oxygen, strychnin, nitrite of amyl, and even digitalis and strophanthin has been suggested. Formerly, there was a tendency to say without reserve that digitalis and its allies are contraindicated in all forms of heart block. With wider experience it seems safe to state that in the failing myocardium, irrespective of the presence and degree of block, digitalis should be tried and unquestionably some of these patients using it are better for it.

In cases of heart block, showing tendency to fainting spells, and especially in those exhibiting the Adams-Stokes

syndrome, one frequently finds that spells are precipitated from some unusual physical exertion, or reflexly through gastrointestinal disturbance.

Arborization Block. Oppenheimer and Rothschild,[45] in 1916, described an abnormal and constant form of electrocardiogram which they thought pointed to a definite kind of cardiac involvement. The criteria which they used in fixing this kind of electrocardiogram were as follows:

1. Abnormal prolongation of the time interval of the Q, R, S group beyond the normal limit of one-tenth of one second. The R wave is broader and often blunter than normal.

2. Notching of the R wave. This notching may appear on the ascending or descending limb, on both limbs, or at the peak. It may be multiple in its degree, and location may vary slightly from beat to beat. In arrhythmias the shorter the preceding interventricular interval, the more pronounced the evidence of disturbed intraventricular conduction.

3. Low voltage as expressed by the low amplitude of the waves in all three leads. This change is not uniformly present but where it is, it helps to differentiate this type from the curves of branch bundle block.

4. The absence of the typical diphasic curves with high T waves found in experimental branch bundle block.

They obtained this permanent type of electrocardiogram in seventeen cases of arteriosclerosis, coronary disease, angina pectoris, cardiovascular renal disease, syphilis, and myocardial disease. Some cases were associated with auricular fibrillation and flutter. They also found that the mortality in these cases is high. In some cases which came to post mortem, examination showed coronary arteriosclerosis with closure of the anterior descending branch of the left coronary artery. This artery supplies the anterior part of the septum. There was a widely disseminated, patchy sclerosis predominating in the endocardial and the subendocardial layers. That is, in the region of the Purkinje network. The changes here were much more marked than in the outer two-thirds of the ventricular wall. Furthermore, they were more marked in the left ventricle than in the right. Their deductions from the electrocardiogram and from pathologic findings were that these abnormal curves are the result of block in the

Purkinje cells which line the greater part of both ventricles and transmit impulses ten times as fast as ventricular muscle, the facility of their conduction thus insuring a rapid simultaneous contraction of all parts of the ventricular walls. The authors consider the electrocardiogram of arborization block as intermediate in form between the normal and that due to branch bundle block. Again, in 1917, the same authors[46] describe sixty-two cases; they drew the same conclusion as to electrocardiographic curves and post mortem findings and find the same serious prognostic significance in these curves. In 1918, Willius[47] described one hundred and thirty-eight cases of this same condition. The hearts in his series showed, post mortem, disease of the subendocardial area. In the same year Carter[48] described a series of cases with practically the same electrocardiographic curves and the same post mortem findings. One gathers from these papers that arborization block is a definite entity, always showing this same type of electrocardiogram, that this type of curves suggests a definite post mortem lesion and that patients showing this form of curve present a poor prognosis. The latter appears true without reservation; the former two conclusions seem yet open to discussion. Experimental evidence does not as yet support the view that the curves of arborization block are definitely connected with the lesions of the descending coronary vessel. Smith[49] ligated the anterior descending branch of the left coronary in dogs, some of which were kept alive for as long as three months, and no electrocardiograms of the type described by Oppenheimer and Rothschild were found. Post-mortem examination showed that pathologic changes in character and location were similar in the dog's heart with the fibrosis found in the human heart by the above workers. In later work Smith[50] tried to imitate the lesions of arborization block by making transverse cuts in the endocardial and subendocardial tissue of the left ventricle, but again he failed to obtain the cardiographic curves of arborization block. Herrick[51] reported a case of coronary thrombosis, in which the post mortem findings were identical with those described by Oppenheimer and Rothschild, and later Drury[52] described a similar case, but in neither of these two cases did the electro-

cardiogram show the findings of so-called arborization block. Abnormal electrocardiograms showing the criteria of arbor- ization block may occur temporarily in other cardiac lesions, as Robinson[53] has pointed out.

The failure of experiment to substantiate the theory, the cases described by Herrick and Drury, the work of Wil- son,[54] the temporary appearance of these bizarre complexes in other cardiac lesions, and also frequently in single leads, suggest that there may be other factors in the production of the curves of arborization block. The fact remains that though there may be some doubt as to the exact cause of these curves of arborization block, there is no questioning the dictum of Oppenheimer and Rothschild as to their bad prognostic significance.

The Premature Contraction or Extra Systole.

An extra systole is a premature contraction arising in the auricle, the ventricle, or in the *A-V* node or main bundle, while the original or sinus rhythm is maintained in most cases. There are then auricular, ventricular, and nodal premature beats, depending upon the seat of their origin. We have learned that normally the heart beat is rhythmic because each au- ricular impulse arises in the sino-auricular node in a fraction of a second which is constant, traverses the auricular muscle and the whole *A-V* connecting system at a uniform rate and provokes contraction of the upper and lower chambers of the heart with unvarying time relationship. Normal im- pulse formation, then, has two main characteristics. It is born at a constant rate and the process tends to repeat itself indefinitely. Therefore, the normal heart mechanism is rhyth- mic, but when some center other than the pacemaker in an irritated heart muscle discharges an early impulse which provokes contraction, the normal rhythm is disturbed. Such a contraction anticipates the regular beat in the series, so it is called a premature beat. The time of the stimulus pro- duction to which it owes its existence is extremely short, and commonly these beats arising in the so-called ectopic cen- ters do not tend to repetition. As already mentioned the ectopic centers giving rise to premature beats are ordinarily in the auricle, the ventricle, or occasionally they may arise

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in the junctional tissues. The presence of an extra systole means that some portion of the heart below the sinus is temporarily more excitable than the sinus itself. Premature beats may be frequent or infrequent, irregular or may occur regularly after each beat, after every second, third, or fourth beat. The ventricular form is the most common; the auricular is next in frequency and sometimes they both occur in the same subject. Premature beats are the commonest causes of intermittence of the pulse; frequently the patient is conscious of the long pauses and beats of large amplitude which follow them, sensations which are distressing and alarming.
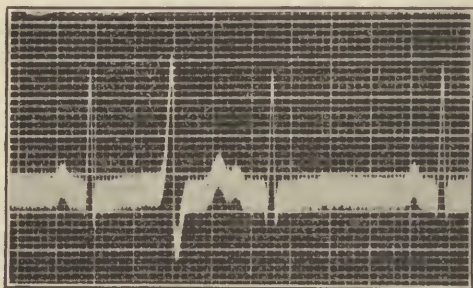
Fig. 20.—Interpolated ventricular premature beat. Its *T* is notched by the *P* of the succeeding normal beat.

The Ventricular Premature Beat. A ventricular premature beat interrupts the ventricular rhythm alone; the auricle continues its original regular rhythm in response to sinus impulses. The impulse which causes the ventricular premature beat arises within the ventricular wall. It is ectopic; its advent is followed by a pause, the ventricle awaiting the stimulus of the next rhythmic auricular impulse. The length of this pause is such as to compensate for the shortness of the diastole which precedes the extra systole; hence it is called the compensatory pause. The normal beat with its short diastole preceding, and the long diastole following the premature beat together are equivalent to two rhythmic beats of the normal rhythm. The regular mechanism existing previous to the premature contraction is resumed immediately afterwards. The premature ventricular contraction commonly occurs synchronously with the auricular contrac-

tion; it may precede it; it may follow it, but in the latter case the extra systole occurs at a time prior to that at which it would have occurred had it been in response to the normal auricular stimulus. The normal auricular impulse falling with the premature ventricular impulse awakens no response in the ventricle because the latter is already in contraction or is in the refractory stage following contraction. The prolonged pause following the extra systole allows the ventricle an unusual time in which to recover and refill, so that the pulse beat immediately following the compensatory pause has often a great amplitude.

When the heart rate is slow a ventricular extra systole may occur between two rhythmic beats; this is called an interpolated premature beat. (Fig. 20.)

The Auricular Premature Beat. The auricular premature beat arises in an ectopic center in the auricle; it is usually followed by a premature contraction of the ventricle, the stimulus being propagated over the *A-V* conducting system. Ordinarily, the preceding heart rhythm is disturbed, for although the premature contraction is followed by a long pause, the whole period of disturbance is not equivalent to two full beats of the normal rhythm as it is in the premature ventricular disturbance. The original rhythm is not ordinarily resumed. Rarely, an auricular contraction, arising in the immediate neighborhood of the *S-A* node, has a pause which is compensatory and the rhythm is undisturbed. Sometimes the first contraction of the restored rhythm following an auricular extra systole occurs rather earlier than normal. This is probably due to the unusual length of the rest period; this tends to shorten the compensatory pause. Sometimes the rate of conduction from auricle to ventricle, in premature auricular contraction, is delayed so that the *a-c* and *P-R* intervals are increased. In this case the prematurity of the ventricular systole is not so great as that of the auricle; the compensatory pause is shortened. In such cases the impulse frequently follows an abnormal course in the ventricle or at an abnormal rate so that it gives rise to bizarre ventricular responses to the auricular extra systole. The ventricular complexes, in auricular premature beats, frequently show this aberrancy. (Fig. 30.) Occasionally, the

premature auricular stimulus fails to reach the ventricle at all and no premature contraction of this chamber occurs. In this event the premature contraction of the auricle stands alone. There is no contraction of the ventricle; this condition is known as blocked auricular extra systole.

The Auriculo-Ventricular or Nodal Extra Systole. (Fig. 21.) Here the stimulus for premature contraction arises in some part of the auriculo-ventricular tissues; it travels upward to the auricle, downward into the ventricle, and incites a premature and simultaneous contraction of both auricle and ventricle. Here the two chambers may contract absolutely synchronously, or the ventricular systole may begin after or before that of the auricle. The compensatory pause may or may not be complete.
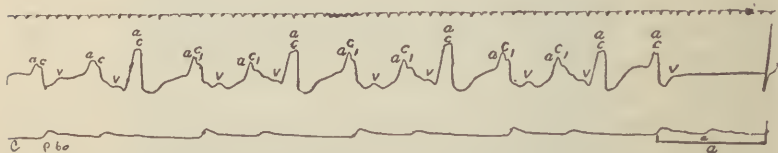
Fig. 21.—Radial and jugular curves from patient showing a trigeminal pulse. Each third beat is a nodal extra contraction in which *a* and *c* fall together. The pause is short of compensatory; *a* represents the length of two normal beats as determined in another curve.

Conditions With Which Associated. Premature beats are common in people who have distinct evidence of cardiac disease. They occur in mitral disease, in aortic disease, in cases of abnormal heart muscle without evidence of valvular disease, as in enlarged heart, and in the senile heart, showing signs and symptoms of inefficiency. They are common in cases of high blood-pressure, especially where this is complicated with digestive disturbance. On the other hand, they are common in individuals where examination fails to reveal any trace of cardiac abnormality. They may occur at all ages, but are most frequent in the fifth and sixth decades; few people having attained these ages have not experienced premature beats at some time. They are commoner in men than in women and occur during or after infectious processes; where present, there is frequently a history of rheumatic fever, of pyogenic infec-

tion, or attacks of the diseases of childhood. Excessive use of tobacco may provoke them. What constitutes an excess is an individual peculiarity; some individuals seem to get sensitized to tobacco. Omission of its use for a time is followed by a disappearance of the extra systole, which is frequently distressing. In the nervous and the fatigued by both mental and physical exertion, both tea and coffee will precipitate them. Patients predisposed to premature beats experience them especially during periods of fatigue, physical and mental; they are seen frequently when the patient is under the influence of digitalis. Increase in pulse rate to one hundred and twenty or above usually abolishes them. Wherefore, where present constantly before, they disappear temporarily after exercise or the onset of fever. Where they
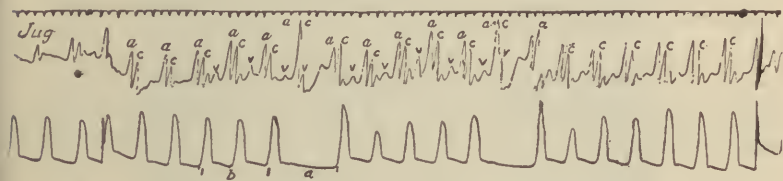
Fig. 22.—Radial and jugular curves from a patient showing ventricular premature beats. In the radial there is the merest indication of the premature beats with corresponding tall waves in the jugular because *a* and *c* fall together, the pause is compensatory. Alternation follows the premature beats.

are suspected they may be brought out in examination by simply holding the breath; they are apt to occur during the arrest of respiration or immediately after its resumption; in some individuals a change in posture will bring them out. Where recumbent or sitting, they may be in abeyance, to reappear when the patient stands upright.

The Recognition of Premature Beats. The information afforded by the polygraph and electrocardiogram enables us to recognize these conditions precisely and points out the means of diagnosis by simple physical signs.

Polygraphic Information. Fig. 22 shows, in the radial, two small premature beats; the length of the disturbance is equivalent to two rhythmic beats; the period *a* equals the period *b*, which suggests that they are ventricular premature beats. The jugular curve shows a regular *a, c, v* wave

with the exception of the tall *a* and *c* waves. Now, the *a* waves are rhythmic. Two ventricular contractions are premature. They fall with the preceding *a* wave, explain the cause of the amplitude of these waves and fix the diagnosis. Note the alternation in the radial pulse following the premature contraction.
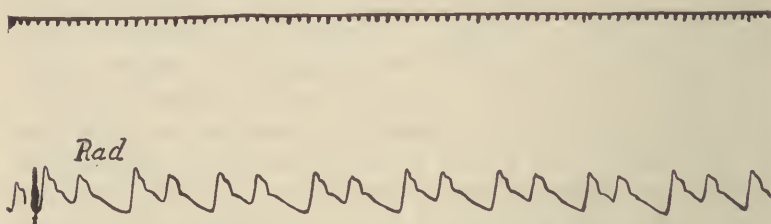
Fig. 23.—Strip of radial pulse showing coupling. Each regular beat is followed by a ventricular premature. There is some sinus arrhythmia.

Fig. 23 is a strip of radial curve showing a form of bigeminy. Each normal beat is followed by a ventricular premature; this fact has been determined in another strip of curve; the coupling is due to digitalis and there is also slight sinus arrhythmia.
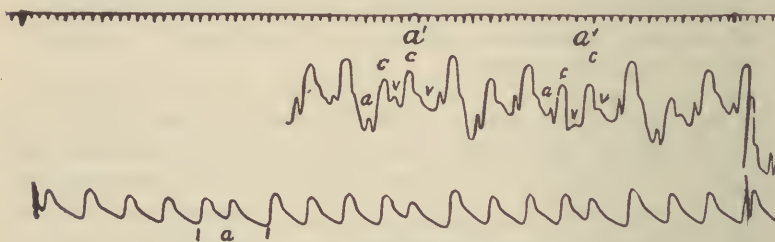
Fig. 24.—Radial and jugular curves from a patient with auricular premature beats. In the radial tracings the pause is short of compensatory.

Fig. 21 shows a curve where each third radial beat is missing or gives but the slightest indication of its presence. This is a trigeminal pulse due to a premature and simultaneous contraction of auricle and ventricle, which causes the high waves $\frac{a}{c}$; the premature beats are nodal. The pause is just short of compensatory. The length of two rhythmic beats is the distance, *a*, determined in another strip of curve.

Fig. 24 shows a curve where the premature beat is of auricular origin. The period of disturbance, *a,* is less than two rhythmic beats. Two auricular beats occur early and excite ventricular beats; this is from the same patient as the electrocardiographic curves of Fig. 31.
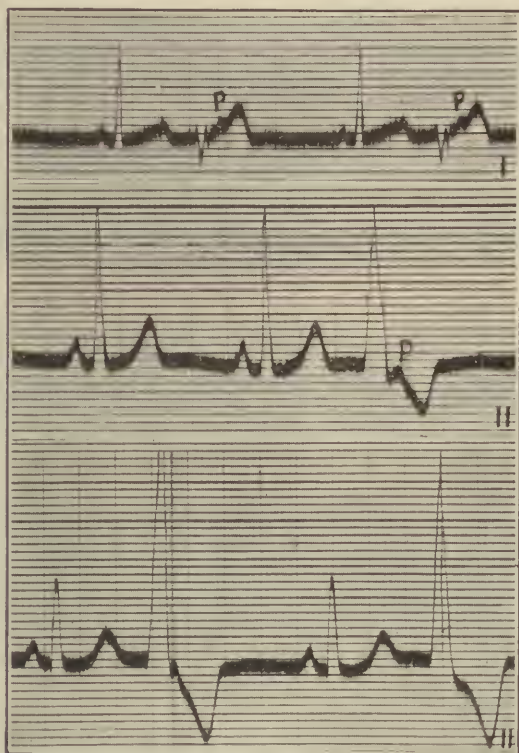
Fig. 25.—Curves from three leads, showing premature beats arising in the right ventricle. Coupling in Leads 1 and III. Not due to digitalis.

Electrocardiographic Curves. Galvanometer curves portray extra systoles most precisely. They separate accurately the auricular from the ventricular; furthermore, in the ventricular they distinguish those which arise in the right ventricle from those which arise in the left ventricle.

Fig. 25 represents the ventricular extra systole arising in the right ventricle in each of the three leads in a single

patient. In Lead I and Lead III each normal beat is followed
by a ventricular premature. In Lead II there are two nor-
mal beats followed by a ventricular premature beat. In ven-
tricular premature beats we saw that the normal auricle
rhythm continued. Note how the auricular complex *P*
notches the ventricular premature complex in Leads I and II;
in Lead III it falls with the descending limb of the ventricular
contraction but is not as evident. This curve illustrates one
form of bigeminy of the pulse.
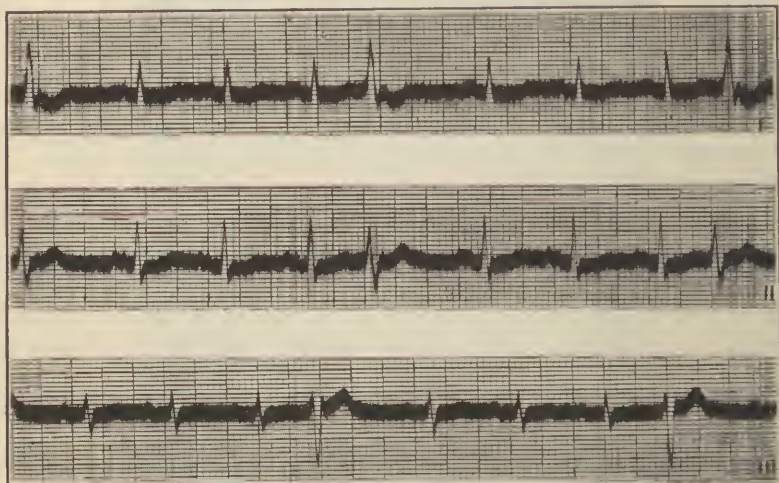
Fig. 26—Shows ventricular extra systoles arising in the left ventricle
in the three leads. The pulse is quadrigeminal.

Fig. 26 shows the ventricular extra systole arising in the
left ventricle in the three leads from one patient. These
curves show a quadrigeminal pulse, as each third normal
beat is followed by a premature ventricular contraction. The
period of disturbance is equivalent to two normal beats
throughout. The curve of the premature ventricular con-
traction in Lead III is characteristic of those arising in the
left ventricle; commonly in Lead II the extra event would
simulate more closely that in Lead III. In Lead I the event
takes the shape portrayed; sometimes it is like that in Lead
III. In interpreting the ventricular premature beat we should
note that they precede and replace a normal beat, that they

have these anomalous but characteristic forms, that they have the same duration as the normal ventricular event which they replace, that the pause is compensatory, that the regular rhythm is undisturbed and that the *P* deflections falling with the ventricular extra contraction can often be
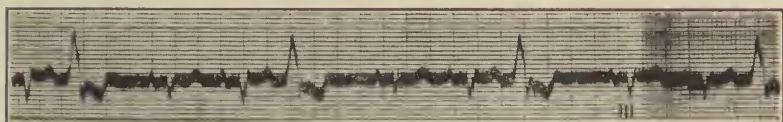
Fig. 27.—A trigeminal pulse, each second beat is followed by a ventricular premature contraction.

identified. Sometimes they are buried but in any case it never occurs regularly before the ventricular event as it does in normal rhythm.

Fig. 27 shows a trigeminal pulse; each second beat is followed by a ventricular premature beat.

Fig. 28 shows ventricular prematures arising in the right
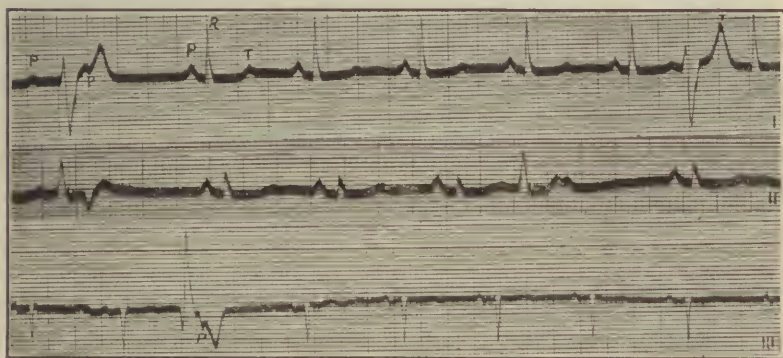
Fig. 28.—Ventricular premature beats arising in the right ventricle. It shows how *P* may be identified.

ventricle; this curve reveals how *P* is identified; in the first ventricular premature beat in Lead I, it notches the upward stroke of *T;* in the ventricular premature at the end of the curve, the *P* and *T* superimpose; in the premature ventricular in the third lead, it notches the downward limb of *T*.

Fig. 29 illustrates many points of interest; the curves taken from an individual show ventricular premature beats arising

in the right ventricle. In Leads I and III premature contrac-
tions arising in the ventricle replace alternate normal ven-
tricular beats and give rise to one form of bigeminy; in Lead
II, two right ventricular premature contractions occur to-
gether; they show how the auricular complex is buried; in
the first, P has almost entirely disappeared, in the second,
it is quite evident. Premature beats one, two and three, in
Lead I, all differ. Premature beat one (P.B.1) suffers dis-
tortion probably from aberrancy, premature beat two (P.B.2)
occurs earlier than premature beat three (P.B.3) so that P
falls with the up stroke of T, whereas in premature beat
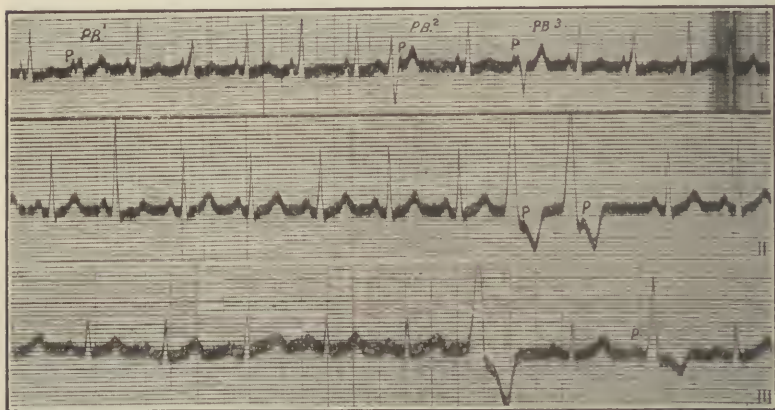
Fig. 29.—Shows premature beats arising in right ventricle. Coupling
and variation in the ventricular complexes are shown.

three. P falls just before the down stroke of S. Note that S
in premature beat three is not so deep as in premature beat
two and the R of extra systole two is missing in extra sys-
tole three. The position which the premature beat occupies
in diastole and its relation to the auricular beat modifies its
form. In this connection the two premature beats in Lead
III are interesting. In the first, P is buried, whereas in the
second, P is well marked and is almost finished before the
premature ventricular beat arises. Here, due to a combina-
tion of two waves—the normal auricular impulse and the
premature ventricular impulse—the ventricular complex takes
the form midway between that of the ventricular premature
beat and the normal ventricular curves in this same lead.[55]

Note that the R is shorter and T less deep than in the preceding ventricular extra systole, but that R is much taller than the normal R and that T is inverted rather than upright as in the normal.

Fig. 30 represents the galvanometer curves of auricular extra contraction as they occur in the three leads of a patient. The fifth event in the third lead shows the same ventricular outline as the rest of the ventricular curves. Therefore, it depends upon a supraventricular impulse, but the auricular impulse causing it is evidently ectopic, because this P alone of all those in the curve is inverted. It is inverted because it has arisen not in the pacemaker but in some other area
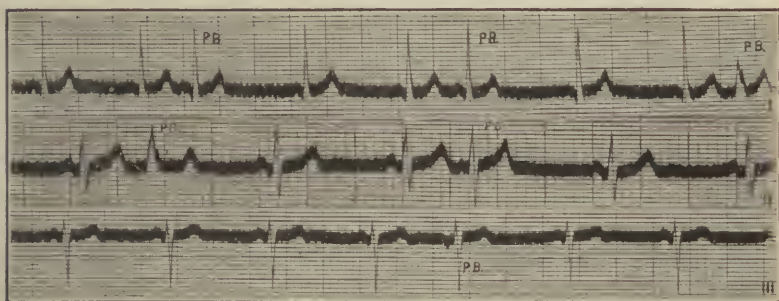
Fig. 30.—Three leads showing auricular extra contractions; some with aberrancy.

of the auricle and has pursued therefore an abnormal course through the auricular muscle which caused its abnormal form. The auricular impulse is premature; it is ectopic and it excites a premature contraction. In Lead I, the third and sixth events are premature auricular contractions; the ventricular deflection has the normal shape but the third and sixth beats occur early. Furthermore, their auricular complexes, though upright, are larger than the normal auricular complex in this curve in this lead. They have arisen near the normal pacemaker but not within it; otherwise the pause following the premature beat would be more nearly compensatory. The last event in Lead I, the second and fifth events in Lead II, represent auricular premature beats; they also show that the impulse has travelled in an irregular manner over the auriculo-ventricular system in the ventricle and

provoked these bizarre forms; they represent aberrancy, which is not infrequent in the curves of auricular premature beats.

In Fig. 31 the fourth and eighth events in Lead I are premature auricular events. The second event in Lead II is a premature auricular contraction with aberrancy. The sixth and ninth events in Lead II are also premature auricular contractions. In contrast, in Lead III each third beat is followed by a premature ventricular contraction, arising in the left ventricle; at first the inverted event immediately preceding the premature ventricular contractions would suggest
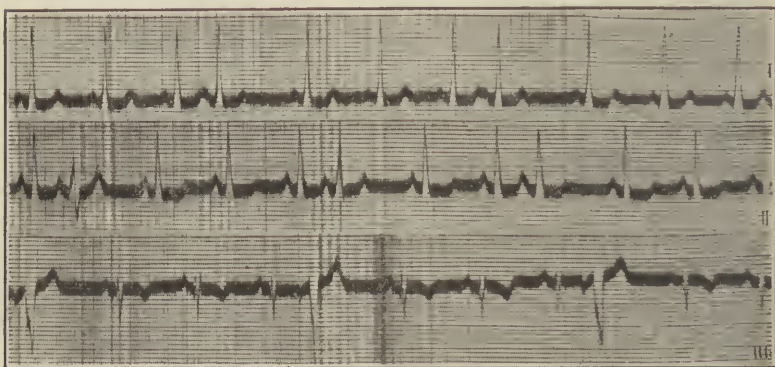
Fig. 31.—Curves from three leads showing premature auricular contractions; also ventricular premature contractions at the same sitting.

a P; in reality it is the inverted T of the preceding normal contraction. In Lead I, we have a quadrigeminal pulse, each third normal beat being followed by a premature *auricular* contraction.

In Lead III, we have a quadrigeminal pulse, each third normal beat being followed by a premature *ventricular* contraction; the curves show that in a single patient, premature beats may arise in two distinct foci. Later this patient developed auricular fibrillation.

Diagnosis of Premature Beats From Physical Signs. It is not possible always to procure tracings of patients with premature beats, though, as we have seen, these methods are most exact. Fortunately, with the information in mind which instrumental means have revealed, it is possible by

physical signs alone to diagnose premature beats in a patient, with a fair degree of accuracy. We make use of the apex beat, the heart sounds, and the radial beat. The categorical statements which follow apply especially to ventricular premature beats. In each particular instance the physical signs will depend upon whether the premature beat opens the aortic valves or whether they remain quiescent

When a single beat of a regular ventricular rhythm is replaced by a premature beat (Fig. 22), an early apex movement will be heard and an early beat felt in the radial. At the apex there will be a group of four sounds, consisting of the first and second, of the premature, and of the preceding normal beat. Under similar circumstances, where the aortic valves do not open, there will be an early apex movement, an intermission in the radial, and triple sounds at the apex, due to the two normal sounds of the rhythmic beat and the single (first) sound of the premature beat.

When each third beat in a regular ventricular rhythm is replaced by a premature beat (Figs. 21 and 27), the apex beats are tripled, the third beat being due to the premature contraction. The radial pulse beats will be grouped in three like those of the apex, and two normal heart sounds will alternate with a group of four sounds. In this form of trigeminal pulse, where the premature fails to raise the aortic valve, the pulse beats are paired with a long intermission between the pairing and two normal heart sounds alternate with a group of three sounds. The apex beats are grouped in threes.

In cases of bigeminy, Fig. 23, where a rhythmic beat is followed by a premature regularly, the apex thrust is doubled, the heart sounds occur in groups of four, and the radial beats are paired, the second of which is weak and premature. In bigeminy of this kind where the premature beat fails to raise the aortic valve, the regular rate of the pulse will be halved and the heart sounds will occur in groups of three. Lewis's diagram,[56] made up from radial curves showing premature contractions, illustrates these points more clearly.

An isolated premature beat is fairly easy to recognize by the premature thrust, the four sounds, and by the weak premature event in the radial. But where an isolated premature

beat is weak, so that there is an intermission in the radial pulse, we must decide whether this intermission is due to a weak premature beat or to a dropped beat of partial heart block. Auscultation of the apex will decide the question. In the case of premature beat, one or two heart sounds will be heard, depending upon the strength of the contraction, but where the intermission is due to partial heart block, no sounds will be heard because the ventricle has failed to contract at all, which has given rise to the intermission.

Pulsus bigeminus and pulsus trigeminus, as we have seen, may be due to extra systole; they may also be due to partial heart block. Their differential diagnosis also rests upon the information derived from the apex.

Fig. 22 shows how a single strip of radial curve enables us to distinguish premature beats accurately and simply. In the premature ventricular beat the period of disturbance is equivalent to two rhythmic beats; a equals b. The compensatory pause is complete. In the case of the premature auricular beat the period of disturbance is less than two rhythmic beats; a is less than b. The pause is short of compensatory. (Fig. 24.) Figs. 21 and 22 show a prominent wave which finds its counterpart, on inspection, in the neck. This prominent wave in the neck, which is often seen, is due to the fact that the premature ventricular or nodal beat is synchronous with the rhythmic auricular contraction. Upper and lower chambers beat together. For a single beat the auricle can not empty itself into the ventricle and the blood is pumped back into the veins. Lewis[57] has also called our attention to the effect of premature beats upon murmurs when they are present. A systolic mitral murmur will be found in the premature as well as the rhythmic beat; it is usually short and it may be wanting. In aortic disease a systolic or diastolic murmur at the base of the heart will occur also with the premature beat if it is strong enough to raise the aortic valve. In mitral stenosis a presystolic mitral murmur is commonly absent, whether the premature beat is auricular or ventricular. But in the case of the auricular premature beat the murmur may be absent but there may be a presystolic sound. There are two reasons for the possible absence of the presystolic murmur in the case of

the premature auricular beat: one is the weakness of this premature event; the other, the fact that it is synchronous with the preceding ventricular systole. It is possible for a premature beat to raise the pulmonary but not the aortic valve. The second sound due to the former is present while the aortic second is absent. This has been attributed to hemi- systole, a condition which, as has already been pointed out, does not exist.

Symptoms. In some individuals premature beats pass un- noticed. In the nervous, the emotional or the fatigued indi- vidual, they may cause anxiety and distress. Where they are multiple, the pause long and the shock of the succeeding beat great, they may give a feeling of faintness, with cold- ness of the extremities. In those predisposed, after the ex- ertion of the day, they are frequently brought on by tobacco, coffee and tea. They are most evident on a full stomach and after retiring.

Prognosis. Premature beats are the most frequent cause of irregularity and intermittence of the pulse; they do not compare in gravity with the irregularity due to other causes. As we have seen, they are frequently associated with definite heart disease, but even in such a case they do not seriously embarrass the circulation and usually add but little to the gravity of the prognosis. The outlook depends not upon the premature beats but upon the cardiac abnormality with which they are associated. On the other hand, they frequently occur in hearts where their presence is the only evidence of disturbance. Here they suggest a nutritional disturbance, either temporary or more or less permanent. But they them- selves alone are not evidence of serious heart involvement. I have known medical men, worn both mentally and physi- cally by the stress of general practice, who suffered great distress from premature beats in the third and fourth dec- ades. This distress was always aggravated by the use of much tobacco or much coffee or tea. In the fifth decade, when these same men were able to do less strenuous medical practice, the premature beats have disappeared for long in- tervals and even when they return under unusual stress or indulgence, they have never been as distressing as they were earlier in life. In these men there was no reason to suspect

any organic lesion; years have seemed to confirm this opinion. Occasionally, other irregularities of the heart arise where the patient has had premature beats but on the other hand, these grave irregularities arise in patients where at least premature beats have not been detected.

Though they are unimportant as compared with many of the other irregularities of the heart, the organ showing them is not absolutely normal for the time being at least, although this need not lead to grave anxiety. Knowing that they frequently consort with actual heart disease, any patient showing them should be subjected to a searching cardiac examination.

Treatment. The presence of premature beats suggests an inquiry into the general health of the individual. Where they are associated with organic heart disease, with incipient cardiac failure, it is the latter that suggests the treatment and not the premature beats. Where they exist, with or without cardiac involvement, a careful inquiry into the general health is important. The gastrointestinal tract comes first of all; secretory disturbances and flatulence are frequently a reflex cause. The patient's habits should be inquired into. The man who does physical labor or takes regular physical exercise can use coffee, tea or tobacco with a freedom that the sedentary brain worker can not emulate. Furthermore, individuals seem to get sensitized to tobacco. Some individuals can take their coffee half an hour before breakfast with no disturbance, whereas with the meal it provokes secretory disturbance and in some of these patients the aggravation of the premature beats. Their presence, especially in the absence of an actual heart disease, calls for exercise, rather than its restriction. Reassurance, rather than medicine, is what these patients frequently need. Digitalis and other cardiac stimulants are almost always contraindicated. The most useful drugs are the nervous sedatives, especially the bromides. Recent experience indicates that quinidin sulphate may lessen or abolish premature contractions which are subjectively troublesome.

Simple Tachycardia.

Simple tachycardia is the rapid heart rate which occurs in fright, emotion, fever, alcoholism, hyperthyroidism, in the menopause, in indigestions with gas, in functional nervous diseases, in infections, and after strenuous exercise. Its cause may not always be so evident; in elderly subjects with no fever it has persisted until a hidden pocket of pus was discovered and evacuated. An educator of sixty, with nervous temperament, sedentary habits and keen observation, found that he had each morning a marked acceleration in pulse rate. Shortly after this observation, in the early morning hours, he developed attacks like laryngismus stridulus. A careful survey of his daily life elicited the fact that he had a much prized laxative pill, given him years before by a physician, and that the prescription had been refilled for several years. As necessity arose, he had increased the number taken at a dose, so at the time of his attacks he was taking a good sized dose of atropin each night. Omitting his pills cured the conditions. He had noticed no unusual dryness of the mouth and no visual disturbance. A few years ago I found a middle aged woman confined to bed with continuous tachycardia and marked dyspnea on arising, which were due to the continuous use of thyroid extract, the prescription for which she had obtained on a visit and continued to renew of her own volition on her return home. Once in a while one finds a woman who is taking thyroid extract for a reduction cure who has not even the excuse that a doctor once gave her the prescription.

Simple tachycardia is merely an enhancement of the rate of the usual rhythm. It is largely a nerve phenomenon, for the electrocardiograph reveals the fact that in this condition the impulse arises in the sinus as usual. This form of rapid pulse is distinguished from the form of rapid pulse due to pathologic impulses by other means. In simple tachycardia, the rise and fall in rate is gradual. In paroxysmal tachycardia its beginning and ending are abrupt. In simple tachycardia the rate is in some degree subject to nervous control. Recumbency for several minutes will almost always reduce the rate noticeably. There is no such marked fall in rate

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induced by changes in position in the paroxysmal form. In simple tachycardia the maximum rate rarely exceeds one hundred and fifty; in other forms it may be much higher, but rate alone is not a satisfactory differential criterion.

Simple Paroxysmal Tachycardia.

Some have contended that there is no reason for separating these patients into a distinct group. This may be true etiologically, but clinically they seem to group themselves automatically and definitely. Simple paroxysmal tachycardia should be limited to patients who show, from time to time, periods of accelerated and regular heart rate, varying from one hundred and ten to two hundred and twenty, the beginning and ending of which are absolutely abrupt. The limits of pulse rate are somewhat artificial; however, the higher rate has a definite basis, for in a rate above two hundred and twenty the ventricle is apt to begin to fail to follow the auricle regularly, so that the ventricular response will become irregular. In simple paroxysmal tachycardia the impulse arises in a single focus; hence the regularity of the heart beat. However, this focus is always ectopic; it is not in the sino-auricular node. In this pathologic rhythm an abnormal focus in the cardiac wall originates impulses more rapidly than the normal pacemaker, so that it seizes the lead and dominates the rhythm. A series of abnormal impulses courses over the auriculo-ventricular conducting system to which the ventricle responds regularly. The points of origin of this pathologic impulse formation are commonly in the auricle. They may arise in the ventricle or even in the *A-V* node. In the ventricular form the auricle beats in response to retrograde impulses carried up into the auricle from the ventricle. Ventricular paroxysmal tachycardia is rare—at least it is hard to demonstrate because its prolonged existence is incompatible with life. Robinson and Herrmann[58] have found that it sometimes occurs with coronary occlusion; the mortality among such cases is extremely high, probably because ventricular tachycardia tends to pass into ventricular fibrillation, which is always a terminal process. For these reasons we have to do almost always with the auricular form of paroxysmal

tachycardia. We shall see also that in its reaction to treatment these patients differ from those of simple tachycardia and auricular flutter.

Conditions With Which Associated. Simple paroxysmal tachycardia may occur at any age; it is commoner between twenty and thirty, and there is a group among the arteriosclerotics later in life. Men are more commonly affected than women. The patients frequently give a history of having had rheumatic fever; sometimes there is only a history of severe attacks of the children's diseases, occasionally of pneumonia, and in others a history of pyogenic infection; syphilitic history is not common. Mitral stenosis is the only valve lesion with which this pathological condition is commonly associated. More often these cases show no valve lesion; however, myocardial degeneration, as shown by chronic enlargement of the heart and limited field of response to effort, is frequent among these patients. Post mortem the hearts have shown fibrosis, atrophy, and interference with the arterial supply. Among the factors precipitating attacks are indigestion with flatulence, unusual exertion, emotional upsets, mental worry and fatigue, and even some unusual posture of the body, as sudden bending to lace a shoe.

Symptomatology. This depends upon the duration of the attack, the ventricular rate during the attack, and the structural condition of the heart muscle, which is best revealed by the degree of heart dilatation during the attack and by the reaction of the heart to exercise between attacks. In duration the attacks may last from a few seconds to a few minutes or for a few hours and extreme cases may run into days. The longest period I know of was one lasting eighteen days but there were occasional short breaks in the rapid rhythm. On another occasion the same patient had an attack lasting fifteen days, apparently without a break. This is the extreme duration. His attacks always lasted days, whereas in other patients seen they have always terminated in a few hours. The short attacks may pass and disturb the patient but little, but where they run over a half hour the symptomatology becomes evident. At first patients complain of palpitation; they appear anxious, pallid; rapid pulsation may be noticed in the veins of the neck; the extremities

may be cold and covered with sweat; gastrointestinal symptoms are apt to appear, such as flatulence, nausea and vomiting. If the attack continues, graver symptoms supervene. Some patients complain of the anginal pain and reveal the hyperalgesia that is present in angina pectoris. I have one patient whose pain has always outweighed, in his mind, his rapid heart rate. As his attacks of pain were infrequent and short, it was a long time before the tachycardia was detected. Careful questioning brought out the fact that the acceleration of heart rate was there but the pain was sufficiently intense to focus his entire attention. That paroxysmal tachycardia with anginal pain is the diagnosis rather than angina pectoris, seems to be borne out by the fact that these attacks have persisted for a number of years. An apical systolic murmur due to a sclerotic valve and arteriosclerotic myocardial disease restrict the patient's activities.

Other patients simply complain of a constriction when the attack begins or during it. The next step is that the heart begins to dilate. We find the apex moving to the left progressively in severe cases, then the pallor gives way to cyanosis, the venous pulsation to marked venous engorgement, and commonly the liver enlarges and becomes tender and may pulsate. The patient begins to cough and spit up blood-stained frothy mucous, which means lung engorgement has set in, the bases become dull, and moist râles are heard on auscultation. Occasionally, the attack runs on to ascites, to general anasarca and death. However, this is unusual. It is the more common experience that when dissolution seems inevitable there is, in a few seconds, an abrupt drop in the heart rate, in one case seen from two hundred and twenty to seventy-six, and with the drop in heart rate comes immediate relief to the patient and a marvelous disappearance of the symptoms and signs due to inefficient circulation caused by the excessive rate. These are the severe cases with damaged heart muscle, which react to excessive demand by dilating. In those with good heart muscle and short periods of rapid heart action the attacks may pass unnoticed.

Diagnosis of Condition. A persistent apex rate of one hundred and fifty or above, in an adult, always suggests a pathologic rhythm. Frequently patients who suffer from

these periods of heart acceleration are conscious of them to some degree. Practically all are aware of the abrupt onset and offset of the attack; at least this history can usually be elicited. ·As already mentioned, an important diagnostic point between simple tachycardia and the paroxysmal variety is that in the latter the pulse rate varies only a few beats whether the patient be lying or standing. Other suggestive points in the diagnosis are the rapid undulations in the veins of the neck, heart sounds which are regular but fetal in character, and the fact that the patients having these recurrent attacks show premature beats during the intervals. In patients having murmurs with the onset of the attack these murmurs are apt to vanish, which is true also in mitral stenosis.

Fig. 32.—Simple paroxysmal tachycardia; apex rate, 220.

The Instrumental Curves. Polygraphic curves show the period of rapid heart action preceded or followed by a regular rhythm which is ordinarily broken by premature beats. Electrocardiographic curves are more valuable because they show ordinarily that the focus from which the new and rapid rhythm arises is ectopic. From the intermittency of the complaint few of these patients find their way into the hospital and the securing of entirely satisfactory curves is difficult. The most satisfactory curves are those taken during an intermission, when the pulse mechanism is normal and again during the rapid rate, so as to contrast the two. Still more satisfactory are the transition from the fast rate to the slow which marks the offset of the attack, or from the slow to the fast rate which marks the onset.

Fig. 32 shows the curve at a fast rate. Fig. 33 shows the electrocardiogram taken somewhat later when the same patient was under the full influence of digitalis, including coupling. I am indebted for Fig. 34 to Dr. Alfred E. Cohn, who gave it to me some years ago. It shows the offset of

an attack of simple paroxysmal tachycardia, in the three leads. In Lead I, the first beat after the long pause is followed by two premature beats, and the last beat but one to the right is a premature beat. The four beats preceding this single premature beat are normal. Contrast the *P's* in these four beats with those of the premature beats; the latter are
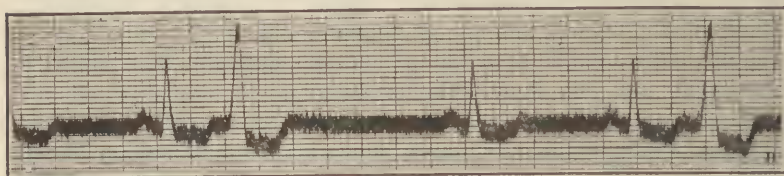
Fig. 33.—Paroxysmal tachycardia from same patient as Fig. 32. Pulse rate, 56; full digitalis effect, with coupling.

small, ectopic, and vary markedly from the tall notched *P* of the normal rhythm. Commonly, the first beat in the returning slow rhythm is normal. Here, the first ventricular complex after the long pause in Leads I and II warrants attention. The *P* is smaller than the normal; the *P-R* interval is shortened, and the ventricular complexes differ from those
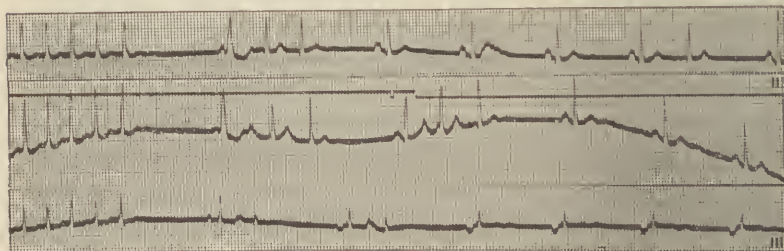
Fig. 34.—The end of a paroxysm of tachycardia of auricular origin, with premature auricular contractions interrupting the commencement of the normal rhythm.

in both the normal and fast rhythm. They are tall, broad, and the *T* variation is wide and depressed, in contrast to the upright *T* in the normal complexes. It resembles a ventricular premature beat occurring late in diastole where two waves of stimulation, that of the normal auricular impulse and that of the ventricular extra impulse meeting in the ventricular walls, incite a response which in contour is partly

normal and partly like ventricular premature contraction. (See page 247.) The first beat of the restored rhythm in Lead II has about the same characteristics. In Lead III, the first beat of the slow rhythm has a P-R interval nearer normal and the ventricular response is nearer normal. The first beat following the long pause in Leads I and II with their short P-R intervals suggest an A-V nodal origin.

The fact that these offsets were induced by deep breathing brings to mind the observation of Wilson, who found during deep breathing in certain patients a displacement of the pacemaker, due to vagal influences, downward even as low as the A-V node. He found that sometimes this A-V rhythm so induced was associated with the ventricular complexes of branch bundle block. In one patient with paroxysmal tachycardia this type of ventricular complex occurred. In Lead I the size and direction of P may not be markedly affected even when the impulse arises in the A-V node. That these two beats—the first following the long pauses in Leads I and II—may arise in the A-V node and their contour be due to aberrancy is strengthened by the existence of prolonged conduction which is especially evident in the two beats following the first beat of the slow rhythm in Lead II.

Leads II and III also show premature beats; this curve also differs from the ordinary curve in that the long pause following the offset of the rapid rate is somewhat longer than those following the premature single beat. This curve also served to draw attention to the similarity between the simple premature beat and simple paroxysmal tachycardia; they both arise in an abnormal focus, the extra systole and the first beat of the rapid rhythm are both premature, and ordinarily the pauses which succeed both in the same patient are of equal length. In reality the rapid period of simple paroxysmal tachycardia is a series of premature beats. Galvanometer curves distinguish simple paroxysmal tachycardia, auricular flutter and simple tachycardia. The first two are genuine cardiac disturbances, while the latter is a disturbance of innervation.

Prognosis. The prognosis depends upon several factors: the frequency and length of the attack, the cardiac rate during the attack, and the reaction of the heart—the presence or

absence of marked dilatation. In patients where the attacks are infrequent and of short duration, there is little danger. In patients with frequent attacks of long duration and with already damaged hearts, the outlook is more serious; however, death in the attack is a rare occurrence. Prophecy as to the frequency of recurrence is impossible. A man of about forty, with a distinct history of acute rheumatic fever in youth, but with no valve lesion, had one attack five years ago, of moderate severity. Since that time he has gone through several spells of mental exaltation followed by depressive states, and whenever seen, his pulse rate is always accelerated; one hundred and twenty is a common rate. There is no suggestion of any acute process in his heart; his electrocardiograms are always normal, and for five years he has never developed a second attack, though his psychic state would seem to render him a likely subject. In a woman of sixty, with evidence of sclerosis the attacks occur very irregularly and the only change during some two or three years has been that the paroxysms, which used to last for minutes, now last from one to three hours. The severity of the attack may be prejudged somewhat by the study of the heart between the attacks; those showing genuine heart disease, as mitral stenosis, or myocardial involvement, as revealed by distress and dyspnea on exertion, appear more prone to severe attacks. However, there is no condition in which the patient may appear on the very brink of dissolution and from which he may recover more rapidly. This is illustrated by the patient (Figs. 32 and 33), a man of middle life, whose first attack followed the evacuation of an ischio-rectal abscess; he had attacks recurring during a period of twelve years, with increasing frequency during the last three years of his life. As has been said, one attack lasted eighteen days with but little break, and one fifteen days where no break at all was found; attacks of from two to five days appeared not uncommon. The few times I saw him his heart rate at the apex was from one hundred and sixty to two hundred and twenty in different attacks. He had on several occasions congestion and edema of the lungs, enlarged liver, and a maximally dilated heart, general edema, temporary suppression of urine, and once delirium for three weeks. He had an anacidity

and other evidences of chronic atrophic gastritis. There was almost always a connection between dietary indiscretion and an attack. He had several attacks of long duration with all the symptoms enumerated and yet with the cessation of the rapid rate, which on one occasion fell from two hundred and twenty-four to seventy-six in a few seconds, terminating the attack of fifteen days duration, he made the rapid recovery which is so marvelous in those patients. Dr. Robert G. Torrey, who had attended him through many attacks, informs me that the patient finally succumbed after an attack of eight days duration. With the fall in rate the heart dilatation begins to subside and with it the engorgement in the liver and lungs. Naturally a sense of exhaustion persists for some time and delirium has been slower in disappearing than other symptoms. The moral is that there is a hopeful aspect in the most exaggerated paroxysm. For when things are at their worst, there may be a sudden offset and recovery may begin at once. Occasionally, in such an attack, the patient develops in addition to the symptoms enumerated, general anasarca, ascites, pronounced delirium, and succumbs.

Treatment. The treatment between the attacks is preventive and hygienic; dietetic indiscretions with dyspeptic symptoms and constipation certainly promote attacks in those disposed. An occupation in which an amount of exertion taxes the damaged heart may have to be changed. However, it is sudden exertion which is more often provocative. Attacks are common under emotional upsets and distress. For the attack itself there is no specific, but recent experience with quinidin sulphate gives hope of a drug that may at least prevent the frequent recurrence of attacks. Paroxysms frequently terminate under treatment, and they sometimes terminate before it is instituted, so that it is difficult to gauge the relationship. However, there are certain procedures the use of which appears helpful in terminating attacks and they certainly add to the comfort of the patient. An ice bag should be applied over the heart and may also be applied to the enlarged and tender liver. Intravenous injections of digitalis or of strophanthin, 1-240 of a grain, have appeared to abolish attacks. Vagal pressure applied to either right or left nerve has sometimes been efficacious. Lying supine or

sitting well bent forward are positions taken by some patients, who think the attacks are more liable to disappear in these positions. Though rest is desirable the patient's wishes should be considered, as some are more comfortable even in a standing position. For pain and sleeplessness, codein or morphin may be used and there is no objection to small doses of chloral. Respiratory embarrassment may be relieved and sleep secured by oxygen inhalations. Progressive and persistent lung and liver engorgement may occasionally call for venesection. In the long paroxysms, especially accompanied by vomiting, feeding may be difficult. Here the food should be liquid and concentrated. A tight abdominal binder is worthy of a trial in the attacks. By some patients it is found useful in preventing attacks if adjusted before arising and worn daily. Others discard it as useless.

Auricular Flutter.

In the normal rhythm the excitation wave arises in the *S-A* node, about seventy-two times per minute and spreads over the auricular wall. Having reached the limits of the auricular musculature, it subsides, to recur when a new impulse flows from the sinus. In auricular flutter it has recently been demonstrated that the time and course of the excitation wave are quite different. Here an excitation wave follows a circular course in the auricle, usually around the mouths of the superior and inferior cava. This wave continues at a rapid rate in a single circuit, in one direction and without intermission. It is the so-called "circus movement." It is comparable to the railway train on the elliptic track in the nursery. In clinical cases the excitation wave completes the circuit two hundred and forty to three hundred and fifty times per minute, regularly exciting an auricular contraction at each circuit. The auricle beats regularly and continuously at these high rates, and each auricular impulse sends a stimulus to the ventricle but the ventricle does not always respond. A certain degree of heart block is present in almost all cases of auricular flutter. It has been found that a marked increase in the auricular rate alone seems automatically to induce depression of conduction—evidently a physiologic safeguard for the ventricle.

Occasionally in children each auricular impulse may stimulate a ventricular impulse. In adults this probably occurs occasionally and is one cause of fainting among these patients. Ventricular flutter is not seen because it is incompatible with life. Usually patients with auricular flutter, when they come under observation, have 2:1 heart block, but they may show 3:1, 4:1, or combinations, or, rarely, complete dissociation. Common clinical auricular rates are from two hundred and sixty to three hundred and thirty, and as these patients have 2:1 heart block, the ventricular rate is from one hundred and thirty to one hundred and sixty-five. As has been said, the auricular rate is regular and uniform, but on account of the block the ventricular rate may be regular and rapid, 2:1 block; slow, 4:1 block; or extremely slow, as in complete block. The latter is very rare. It may be irregular where the ratio of block is a mixed or changing mechanism. There is one characteristic of the pulse that is constant, even when irregular, namely, a pulse beat will fall at a calculated time because the ventricular beats are all incited by a regular series of auricular beats. This makes possible diagnosis from spacing of the arterial curves.

Conditions With Which Associated. Occasionally cases are reported in childhood, but they are rare. As many cases are associated with arterial sclerosis they are commoner in advanced life. Intracardial murmurs may or may not be present. Most cases show impaired cardiac response to effort. In some cases there is a history of rheumatic fever, syphilis, and occasionally puerperal infection. There are no specific pathologic changes. In a recent case (Fig. 37) arterial degeneration and muscle atrophy were extreme, and especially so in the right auricle.

Identification of Auricular Flutter. Hertz and Goodhart[59] first drew attention to the condition. They discovered it in examination of a patient with the fluorescent screen. In two cases recently we failed to observe this in the x-ray room; however, both were over nourished, the thorax being well covered with muscle and fat.

The polygraphic method helps somewhat in diagnosis. In the jugular curves the small waves due to the auricle (*a*) may be seen during diastole, and the one preceding the sys-

tole of the ventricle is usually most marked (see Fig. 35):
A strip of carotid or radial curve alone may be useful for
diagnostic purposes. Because each ventricular beat follows
an auricular beat of a regular series, the ventricular beats
in the arterial curves occur at points which can be expected,
and such curves can be spaced. Those who wish to pursue
the subject of spacing will find it in Lewis's Mechanism,
page 272.

The arterial curves when the rate is rapid may show alter-
nation. Occasionally this is present in the electrocardio-
graphic curves.

Electrocardiographic Curves. Electrocardiographic curves
usually reveal the condition best of all, especially in Leads II
and III. In Lead I there may be no evidence of the auricular
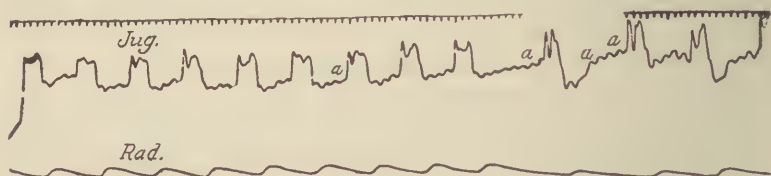
Fig. 35.—Jugular and radial curves from patient with complete heart
block and auricular flutter. Notice the small waves *a,* in the long
diastole, produced by auricular action. Alternation well shown in
electrocardiogram is not brought out here. Polygraph curves were
always difficult to get in this patient. Apex rate, 36. From same pa-
tient as Fig. 39.

impulse or but slight deflections (Fig. 36). Fig. 36 shows
the curves in three leads where 2:1 block is present. In
Leads II and III the condition is evident. This figure also
shows that premature beats may interrupt the regular rhythm
of the ventricle, as there are two in the first and two in the
third lead. The auricular rate of this patient was three hun-
dred and twenty and the ventricular rate was one hundred
and sixty. Fig. 37 is from the same patient, taken eight days
later and under the influence of digitalis. Four-to-one and
2:1 block are present and are best revealed in Lead II. The
apex beat was somewhat irregular and the rate from eighty
to eighty-eight. Fig. 38 was taken three days later, when
flutter passed into fibrillation. The man never recovered his
normal rhythm but continued to fibrillate for six years after

this, when he succumbed to either intracerebral embolus or apoplexy. Fig. 39 is taken from a woman who had complete block with auricular flutter, the apex beat being thirty-six and the auricular rate two hundred and forty. This curve illustrates, especially in Lead II, the constancy in form and
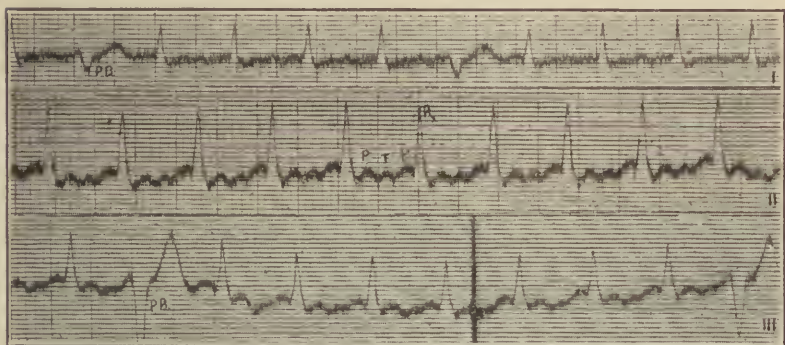
Fig. 36.—Auricular flutter, with two to one heart block. Auricular rate, 320. Ventricular rate, 160. Premature beats in Lead I and III. From the same patient as Fig. 37, but before the administration of digitalis.
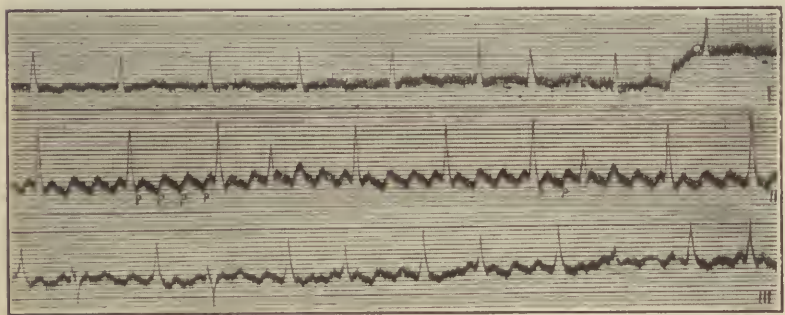
Fig. 37.—Three leads from a patient with auricular flutter. Lead II shows clearly two to one and four to one heart block. Auricular rate, 320. Ventricular rate in the eighties. Lead III shows coupling. Patient was taking digitalis.

contiguity of the auricular complexes, distorted only where they fall with the ventricular contraction. This constancy in form and regularity suggests that they arise from a rhythmic stimulus. Auricular curves have a constant form in the same patient, furthermore, they show the same characteristics in

a series of patients. The high regular *auricular* rate is not influenced by posture, by exercise, by vagal pressure or by digitalis, but occasionally deep breathing may slow the rate slightly. When we examine the ventricular responses we find that they are the type due to supraventricular impulses. This is to be expected ordinarily, since each one is incited by one of a regular series of rhythmic auricular beats. The ventricular rate depends upon the ratio of block present, varying in these curves from one hundred and sixty to thirty-six. Unlike the auricle, the ventricle is fortunately subject to vagal influence, as pressure on either vagus will decrease
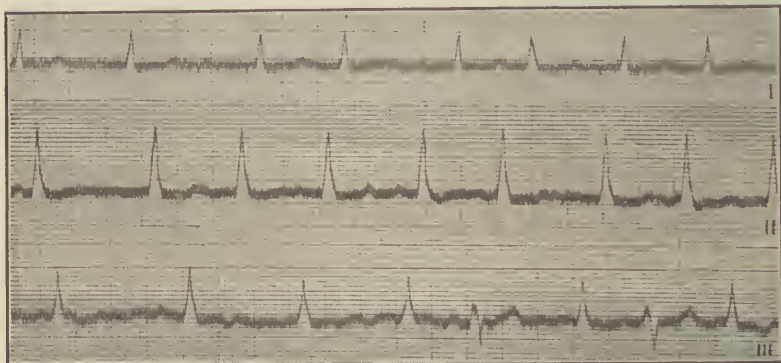
Fig. 38.—Auricular fibrillation following auricular flutter, due to digitalis. Note coupling in Lead III.

conduction and slow the ventricle. Digitalis slows the ventricle, partly by vagal stimulation and partly by its direct influence on the junctional tissues. It prolongs the refractory period of the *A-V* node.

Identification of Auricular Flutter by Physical Signs and Symptoms. A persistent, regular, constant and rapid rate at the apex, at each examination in an elderly subject, arouses suspicion of auricular flutter. Where this rate is from one hundred and thirty to one hundred and sixty, and occurs day after day, it is suggestive of auricular flutter with 2:1 block. It is more suggestive if it is uninfluenced by posture, rest, and exercise. Paroxysms of flutter are less common but do exist and they may be confused with simple paroxysmal tachycardia. Differential points are that at most an attack

of paroxysmal tachycardia lasts not more than a fortnight, while auricular flutter persists months and even years. Again, simple paroxysmal tachycardia is more commonly associated with signs of cardiac failure with congestion than is auricular flutter. In simple paroxysmal tachycardia the apex rate is frequently from one hundred and eighty to two hundred and twenty. Granting the presence of 2:1 block this would make the auricular rate of three hundred and sixty to four hundred and forty, both of which are too high for clinical flutter.

In flutter with irregular responses, even slight exercise will steady the pulse, which tends to become regular, the higher grades of block giving way to 2:1 block. In higher
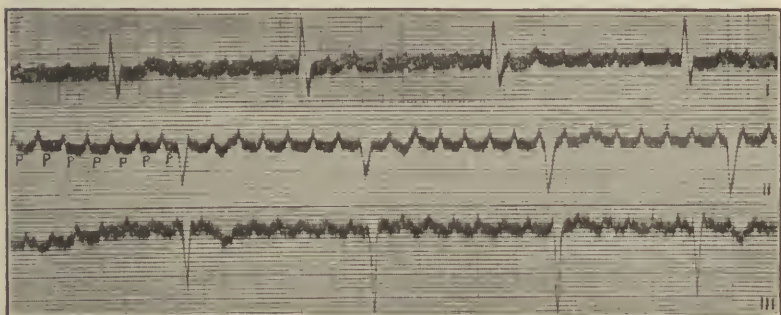
Fig. 39.—Three leads from a patient with auricular flutter and complete heart block. Auricular rate, 240. Ventricular rate, 36. Alternation shown in the depths of S. Left preponderance. This abnormality was spontaneous. No drugs at all taken.

grades of block, as 4:1, the pulse may be within normal limits, as for instance in Fig. 40, Lead III. These are even more difficult to diagnose by simple clinical means than other rates but all are accurately diagnosed by instrumental methods.

Symptomatology. For some unknown reason patients bear auricular flutter better than they do simple paroxysmal tachycardia. Their life may be circumscribed, they may fatigue easily, but the majority of them do not tend to the cardiac insufficiency shown in a case of simple paroxysmal tachycardia, in spite of the fact that the high rate is maintained through weeks, months and even years. Occasionally a patient may lose consciousness, which may be due to the

fact that for a short period a ventricular rate has kept pace with the auricle. In cases with poor cardiac reserve the patient may have a cardiac breakdown and the symptoms are similar to those described in simple paroxysmal tachycardia.

Prognosis. The prognosis depends on the same factors spoken of in simple paroxysmal tachycardia. The better the ventricle the better · the outlook. The fewer symptoms of cardiac insufficiency the patients have when they come under observation the better, and their response to treatment is the best indication of all for the future.
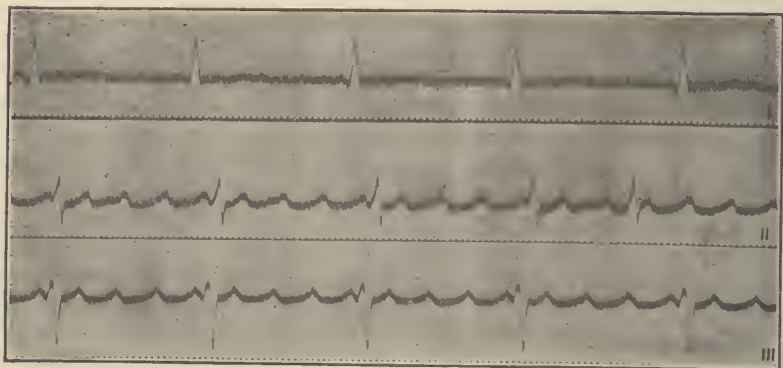
Fig. 40.—Regular four to one block in Lead III. A curve obtained from Dr. Thomas Lewis.

Treatment. Digitalis and its allies will reduce the ventricular rate in auricular flutter by increasing the degree of heart block. The original 2:1 block, common in these patients under the influence of the drug, will pass to heart block of higher grades. The regular rhythm of 2:1 block gives way to an irregular rhythm, as shown in Fig. 37, where 2:1 and 4:1 block are present. Sometimes if the drug· is continued the pulse may become regular again by the establishment of 4:1 block. (Fig. 40, Lead III.) In the majority of cases if the digitalis is continued the auricles pass into fibrillation and if the digitalis is withdrawn at this point the permanent normal rhythm of the heart may return and persist. On the other hand, the fibrillation may persist. It continued for years in the patient whose curves are shown

in Fig. 37. Intravenous injection of strophanthin acts the same as digitalis and more quickly. In the rarer cases with heart failure and congestion, slowing of the rate with digitalis ameliorates the symptoms. Digitalis in auricular flutter probably acts not only by its influence on conduction in the *A-V* conducting system but it is supposed partially to block the excitation wave in the auricle.

Quinidin sulphate is worthy of a trial in auricular flutter. Under its influence occasionally a patient with auricular fibrillation will develop auricular flutter and finally a normal rhythm.

Auricular Fibrillation.

Auricular fibrillation is a condition in which the auricles fail to contract as a whole, their muscle walls show rapid, delirious fibrillary twitchings, the normal regular auricular impulses are wanting, and instead a hoard of rapid irregular auricular impulses incites totally irregular ventricular contractions.

This total and perpetual irregularity of the pulse was known and studied in man for a long time, but experiment alone fully explained the mechanism. In the normally beating heart of the animal, auricular and ventricular systoles can be readily seen; furthermore, this regularly beating auricle, by electrical stimulation, can be thrown into fibrillation. In this condition the auricle stands in a position of apparent diastole, and partial or complete systole is in abeyance. However, though the auricles as a whole stand immobile, on close inspection the auricular wall reveals continuous rapid twitchings and undulations on its surface. Recent experimental work has explained this auricular delirium. It shows that auricular fibrillation is allied to auricular flutter, but there is a distinct difference. As we have already seen, auricular flutter is due to a "circus movement," a rapid regular excitation wave traveling continuously in a single circuit. Centrifugal waves, incited by this smooth regular current, flow over the auricle, traverse the auriculo-ventricular conducting system, and incite rapid, *regular*, ventricular contractions. Auricular fibrillation is also due to a "circus movement," according to Lewis, but there is this difference,—in

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auricular fibrillation there is also one "circus movement," but instead of keeping a single path, this wave tends to change its route continually. The result of this is, that rapid irregular centrifugal waves flow from this circus movement over the auricle and auriculo-ventricular conducting system, inciting rapid, *irregular,* ventricular action. Such is the picture that can be produced at will in the experimental heart, and we now know that the condition in man is completely analogous, with one exception—in experiment the heart is normal and conduction perfect, so that the ventricle responds readily and the ventricular rate may be tremendously increased. In man, the heart is diseased and conduction is often depressed, so that the ventricular rate may vary anywhere between thirty and two hundred, depending upon the facility with which the multitude of impulses reaches the ventricle. Ordinarily, in clinical cases, the ventricular rate is from one hundred to one hundred and fifty.

The Conditions With Which Associated. There are two distinct groups, the rheumatic and the non-rheumatic. The rheumatic group occurs more frequently from twenty to forty years, the non-rheumatic group from fifty to sixty. The non-rheumatic group is more common in men and the rheumatic group commoner in women. This finds a partial explanation in the fact that rheumatic mitral stenosis is commoner in women, and auricular fibrillation and mitral stenosis are frequently found together. At least fifty per cent. of the cases of mitral stenosis are liable to show fibrillation at some time. This irregularity is also found, but less often, in aortic disease, more often in arteriosclerosis, sometimes in a contracted kidney. Cases late in life are often associated with myocardial degeneration. The commonest preceding infections, by all odds, are rheumatic fever and chorea, sometimes pyogenic infections, and occasionally syphilis. The gross pathologic findings are mitral stenosis, other valve lesions occasionally, chronically enlarged hearts, and sometimes cardiac arteriosclerosis without enlargement. Histologic findings show a subacute or chronic inflammation of the auricular wall, with leucocytic infiltration, fibrosis, and atrophy of the muscle cells. There is neither gross nor microscopic pathology found in the heart characteristic of auricular

fibrillation. The same pathologic picture is found in hearts that have never shown fibrillation.

The Identification of Auricular Fibrillation. In auricular fibrillation, then, we are dealing with an abnormal heart mechanism in which coördinate, effective contraction of the auricle is wanting, so that the evidence of auricular contraction will not appear in the polygrams (the *a* waves) nor in the galvanometer curves (the *P* waves). Furthermore, due to the delirium of the auricle, we have a totally irregular ventricular action. However, with the evidences in mind afforded by experiment and by the exact methods of ex-
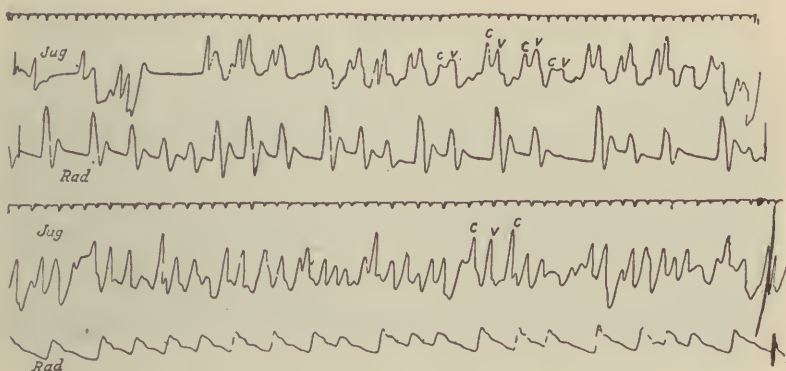
Fig. 41.—Two polygraph curves showing the radial and jugular curves in auricular fibrillation. Both show the ventricular form of venous pulse and irregular ventricular action. Rate in upper is 85; in the lower, 105.

amination, the clinician can diagnose perhaps ninety per cent. of auricular fibrillation cases by physical methods alone. In the remaining ten per cent., among them those with slow ventricular action, a sure diagnosis can be made by instrumental methods alone. We will first consider the evidence afforded by the polygram and the electrocardiogram, and follow with a discussion of the diagnosis by means of physical methods alone.

A strip of radial pulse curve alone is often sufficient for diagnosis. (Fig. 41.) The pulse beats show an intermingling of strong and weak beats, the latter often dicrotic; rarely do two beats of equal length succeed each other; the arrhythmia is absolute; there is no phasic variation; the curves do not

space as they do in other irregularities; the pauses between the beats are of varying lengths; the strength of a beat following a pause is not in proportion to the length of a pause; a large beat may follow a short pause, and a small beat a long pause. Where the rate is fast, from one hundred to one hundred and fifty, the irregularity is usually quite evident. With a slow rate, careful measurement from cycle to cycle may be necessary. The cycles will always show variations, however slight, in length. In the venous curve there is a constant absence of the *a* wave, which absence is due to want of auricular contraction. In this irregularity the ventricular form of venous pulse is always present. The two or three peaks and dips, which usually occur, are all confined
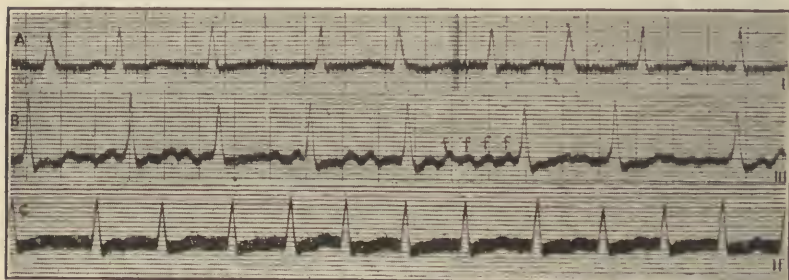
Fig. 42.—Three curves of auricular fibrillation from different patients. A-Lead I: Apex rate, 84, patient taking digitalis; *R* deflections irregularly placed; no *P* variation; small oscillations here are due to muscular tremor.

B-Lead III: Apex rate, 112; coarse oscillations; well developed in some diastoles and tend to disappear in others.

C-Lead II: Apex rate, 140; increase in rapidity causes the oscillations to disappear almost entirely.

to the time of ventricular systole. The venous pulsations are irregularly spaced, just as are the arterial pulsations. The *f* waves which are often present in the venous curve, especially during the long diastole, are evidence of auricular fibrillation. They are rapid, small, not constantly shown, and not found in other curves.

The Electrocardiograph Curves in Auricular Fibrillation. The ventricular complexes (Fig. 42) in auricular fibrillation are of the supraventricular type, as the impulses have arisen in the auricle. Each ventricular complex shows an *R* and *T* or

a *Q, R, S* and *T* group. *R* is commonly present, because it
is too rapid to be distorted by the oscillations. The *R's* are
irregularly placed in the curve, and there is no distinct rela-
tionship ordinarily between the height of the *R* and the
length of the preceding pause. The ventricular complexes
may show some of the same variations seen when the beat
is regular. Auricular fibrillation may be associated with the
ventricular complexes of preponderance (Fig. 43), of branch
bundle block, or with ventricular extra contractions (Fig.
44), but not with auricular premature beats, because in au-
ricular fibrillation the abnormality in the auricle is maximal.
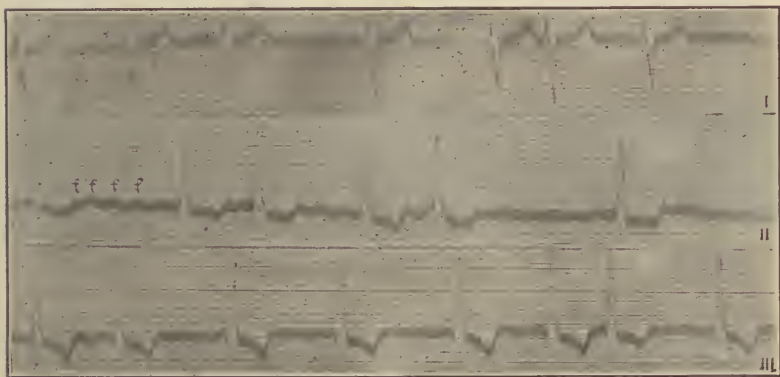
Fig. 43.—Three leads in auricular fibrillation under full digitalis.
R-S deflections irregularly placed. Oscillations marked in the long
diastoles. Right preponderance. Measurement on the plate where the
time marks are present, show the width of *R-S* slightly less than one-
tenth of a second. *T* inverted, especially in Lead II and Lead III.

Aberrancy occurs rarely (Fig. 44); flattening and inversion
of *T* is common and any degree of heart block may be pres-
ent. It is by decreasing conduction that digitalis acts in
auricular fibrillation. Lewis has recently shown that this
decrease of conduction produced by the digitalis series is due
in part at least to prolonging the refractory period of the
A-V node. The curves show a slow ventricular rate with
irregularly placed *R's*, or there may be complete block where
the auricle is fibrillating and then the ventricular responses
are perfectly regular—regular because they are responding
to an impulse which is arising below the auricle. This new

center is often well up in the bundle and the ventricular rate in these cases is often unusually rapid. In complete block the ordinary rate in these cases is thirty, but in complete block with auricular fibrillation I have seen the rate as high as sixty, and Lewis records a case with a ventricular rate of ninety. Under the influence of digitalis, coupled beats and frequent ventricular premature beats often arise, both of which are signs that the drug should be withdrawn.

In the curves of auricular fibrillation, the P complex due to auricular contraction is constantly absent. However, during diastole, the line instead of being iso-electric shows oscillations (Fig. 42, B) which are due to the fibrillary twitching in the auricle and are comparable to the f waves in the polygram. The oscillations are variable in shape, size and fre-
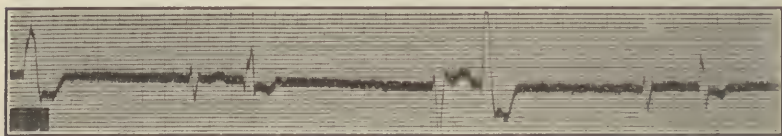
Fig. 44.—Auricular fibrillation with full digitalis effect. Apex rate 52, with coupling. Oscillations show in long diastoles. Premature beats are bizarre suggesting aberrancy. Second coupling suggests two premature beats in succession, the first arising in the left ventricle and the second in the right ventricle; this curve illustrates the undesirability of taking digitalis unless under occasional observation; pushed this far it becomes a sudden poison. Sudden death is a possibility.

quency, in the same case, and are often large in mitral stenosis. They are better seen in Leads II and III, and they are apt to disappear entirely when the rate is very rapid (Fig. 42, C). In a single lead they are more evident in some intersystolic spaces than in others, and they frequently distort the T variations. Sometimes they are regular enough to suggest flutter, but even then they are never quite even from pause to pause or from lead to lead, as in auricular flutter. These oscillations appear only when P is absent and the ventricle is irregular. They are not due to muscular tremor, for where this is present, as in exophthalmic goiter, the P, R, T events can still be identified. That they are due to the undulations in the auricle is shown by the distinctness and regularity with which they appear when electrodes are placed

on the chest wall immediately over the auricle, in man, or, in experiment, directly upon the auricle.

Recognition by Physical Examination. Palpation of the radial pulse shows a mixture of beats of many sizes and varying pauses, strong, weak and lost pulse beats intermingling, and the more irregular the pulse, the surer the diagnosis. The slow irregular pulse may need exact methods to fix the diagnosis. The count at the radial is frequently less than at the apex; because many small beats fail to get through to the wrist, there is a pulse deficit. Auscultation of the apex reveals its disorderly action and varying sounds; first and second sounds are present when the beat opens the aortic valve. When it fails, the first sound stands alone. Where a mitral systolic murmur is present, it persists with a slow rate but disappears with a rapid rate. The presence or absence of aortic murmurs depends upon the strength of the individual beat. In mitral stenosis, the short presystolic murmurs, present with regular heart action, disappear with rapid fibrillation, but if the diastolic murmur is long and rough, it persists during fibrillation. If the heart rate is slow, this murmur may be early diastolic and suggest aortic regurgitation, but a diagnosis of aortic regurgitation in slow auricular fibrillation should not be made from a murmur alone, especially if confined to the region of the apex. The other signs must also be present, as a diastolic murmur at the second cartilage, the water hammer pulse, and increased pulse pressure.

There are certain general observations of diagnostic value. A persistent irregularity of the radial pulse and of the ventricle at the apex, especially with an increased pulse rate, suggests auricular fibrillation. In a patient where mitral stenosis has been known to exist, the development of an irregular heart action is almost always due to auricular fibrillation. A persistent irregularity, especially where the rate is one hundred and twenty or above, is apt to be due to the same cause, especially if the patient has had any symptoms of cardiac failure. Where the pulse appears irregular, but not much above normal, especially if there are no signs of cardiac failure, the reaction of the heart to increase in rate should be studied. Now, the pulse rate may be increased by

exercise or by a few whiffs of amyl nitrite and with the in-
crease in rate the irregularity increases in auricular fibril-
lation, whereas with an irregular pulse due to extra systolic
arrhythmia or partial heart block, an increase of pulse rate
steadies the heart action.   Extra systoles are comparatively
rare with a pulse above one hundred and twenty. As the
pulse rate falls, in auricular fibrillation, the irregularity
grows somewhat less, whereas in other arrhythmias, the
irregularity increases.

Symptomatology.   Where there is no other sign of heart
failure, the patient with auricular fibrillation may be con-
scious of his irregularity, and find that he easily experiences
exhaustion and dyspnea. Where the rate is slow, many cases
continue with no further distress, except under some unusual
exertion. Where there are definite signs of heart failure, the
symptomatology does not differ materially from heart failure
with a regular rhythm. The irregular pulse is but an added
sign of myocardial involvement.

These patients are particularly free from anginal symp-
toms, but recently I have had under observation a woman
of fifty, who had rheumatic fever thirty years ago.   How
long she has been fibrillating I have no means of knowing
but it has persisted over a year. She came for pain and ten-
derness involving the left side of her neck and left scapular
region. The history brought out the fact that the pain started
substernally, radiated to the shoulder, the neck and the left
arm.   Furthermore, examination showed the usual hyper-
asthesia in these areas. The apex rate when she was first
seen a year ago was one hundred and thirty, and in spite
of the fact that she had been able to lead a quiet life, it is
hard to get the rate below one hundred, even under treat-
ment.   However, by avoiding stairs, four flights of which
she was using constantly before, she lives a comparatively
comfortable life. Occasionally, she exercises too freely and
there is always a close relationship between the increase in
pulse rate and the exaggeration of the anginal pain.   In
mitral stenosis, clotting of blood in the auricles, and embolus
of the brain and lung, are frequently seen. Auricular fibril-
lation with the auricle at a standstill offers an unusual op-
portunity for the formation of clots in the appendices, though

as Lewis has observed, embolism does not appear to be more frequent in auricular fibrillation, except in those cases where auricular fibrillation has been succeeded by regular rhythm. The supposition is that the clots form during fibrillation, remain quiescent because the auricle is inactive as a whole, but with the return of the normal rhythm, particles are more apt to be detached and swept to lung or brain, causing embolism. As the statistics of quinidin treatment increase, we shall have new insight into this relationship.

Prognosis. Where auricular fibrillation occurs with mitral stenosis, with other valve lesions, with chronically enlarged hearts, with marked arteriosclerosis, and with kidney disease, the prognosis is largely determined by these associated conditions. Naturally, the totally irregular ventricular action is an added burden to an already overtaxed heart, but that the immobile auricles play much part is doubtful, especially if we look upon them as simply elastic reservoirs, as maintained by Henderson. In heart failure with this irregular pulse, the outlook is better ordinarily than in heart failure with a regular pulse. Patients with the former are more apt to respond to digitalis. Auricular fibrillation occurs frequently in hearts where it is the 'only sign of myocardial involvement, and its presence always means a diseased heart muscle. In these patients, the heart rate is the important sign of the future welfare of the patient. With a rhythm but little above normal, and with an occupation which does not make strong physical demands, these patients may live for ten years.

I have artisans on the list who have worked regularly for eight years and they are apparently no worse today than they were originally. These are the hearts that respond to digitalis when the patient begins to experience discomfort. There is no better index for the future than the reaction of the patient to treatment. A patient with a pulse that persists above one hundred to one hundred and twenty in spite of treatment, will probably not survive many years. A persistent pulse rate of from one hundred and forty to one hundred and sixty, in spite of treatment, reduces the expectancy to months or even weeks. Frequent premature beats and a high pulse deficit (above twenty) are of bad significance.

The ease with which these patients can and will spare them-
selves is important.   One finds women using stairs instead
of elevators, and tampering with preparations containing
thyroid, both for reduction cures.

Treatment. There are two drugs that stand out preëmi-
nently in the treatment of auricular fibrillation: digitalis,
with its allies, and quinidin sulphate.

Digitalis. The great reputation of digitalis in heart disease
is founded upon its ability to slow the heart in auricular
fibrillation.   Its action is twofold: by increasing the refrac-
tory period of the *A-V* node it depresses the conductivity
of the auriculo-ventricular connecting system, which pre-
vents so many of the irregular stimuli from reaching the
ventricle; it also increases vagal influence over the ventricle.
Except in those cases of auricular fibrillation where the ir-
regularity is abolished by quinidin and the returning rhythm
remains regular, almost every case of this disorder will need
digitalis at some time during its progress.   Auricular fibril-
lation when once established, especially in those cases where
quinidin proves unsuccessful, is a persistent condition.   It
usually lasts the rest of the patient's life. The guide to the
use of digitalis is the heart rate of the individual. Wherever
this exceeds one hundred while the patient is at rest, digi-
talis should be used.   In the young, with a history of rheu-
matic fever or of chorea not remote, the reaction ordinarily
is quite prompt.   Where the condition is of long standing
and in the arteriosclerotic cases, especially with a higher
heart rate, the reaction may not be so prompt or so satisfac-
tory.   Depending upon their reaction to digitalis, cases fall
into three groups: In the first, the heart having been slowed
by digitalis, with withdrawal of the drug, the slow rate per-
sists—these cases are few; in another group, the slowing of
the heart brought about by digitalis may be maintained by
continuing small doses, 5 minims two or three times a day;
in a third group, it takes much larger doses to hold the heart
within bounds when the patient gets around. The prepara-
tion of digitalis used is a good tincture (10 to 20 minims
three times a day). a freshly made infusion (2 drams three
times a day), or the powdered leaf in capsule (1 grain three
times a day). The only advantage of certain proprietary

preparations is their uniformity. Any preparation of digitalis in these doses which does not give some slowing of the heart rate in three to five days should be discarded and a new one substituted. In many cases of fibrillation in the doses given above, the heart rate can be brought back to normal in four or five days. The drug should always be reduced or discontinued when the rate falls to between seventy and eighty. If the heart rate goes up again, small doses can be ordered once more. The appearance of coupled beats is always a danger signal, as they ordinarily do not appear until the patient has had more digitalis than he really needs. In some cases of fairly high rate one fails to get a slowing of the rate until the amount is pushed up to the full physiologic limit, nausea, headache, perhaps diarrhea, and often the slowing appears only at this period. Six to eight drams of the tincture or its equivalent will usually produce this reaction. With the onset of these symptoms, the drug may be withdrawn and the slow rate may continue, or we may have to give smaller doses to hold it within bounds. Occasionally, patients are seen with a very high rate, 160 to 200, where the danger is great. In these cases, quick action is necessary and strophanthin (grain 1-240) in one dram of normal salt solution, should be given intravenously. It should be repeated every two hours for three, or at the most, four doses. In that time the apex rate ordinarily will fall to the neighborhood of eighty if a reaction can be secured at all. Following this, digitalis may be administered and the slow heart rate maintained. Some patients are intolerant of digitalis, so that persistent nausea is precipitated long before one can get a reaction. In these patients tincture of strophanthus, in ten or fifteen minim doses three times a day, may be tried; sometimes this is not well borne and one must have recourse to strophanthin intravenously. In these patients squill also can be used, in the form of the tincture or the powder in capsule. As White, Balboni and Viko[60] pointed out, the dosage of squill must be two to four times that given in the books, if results are to be obtained. In patients with fibrillation who are up and about after treatment, the pulse rate and symptoms must guide us. Where the pulse rate is slow, and the occupation makes no strong

physical demands, these patients may go on indefinitely. Occasionally, some unexpected exertion will increase the pulse rate and their dyspneic condition, and in many of them a recourse to digitalis improves their condition again. Naturally, lighter occupations are desirable for all patients with auricular fibrillation, and simple food and simple living are necessary. In the epidemic season they should avoid gatherings, where they are apt to contract colds, and a bronchitis with a cough will often tip the scale in the wrong direction. This suggests that belladonna and hyoscyamus are undesirable, as they depress the vagal control and tend to increase the ventricular rate. In auricular fibrillation, pregnancy is fraught with great danger.

Any case of auricular fibrillation, in which the pulse rate can not be lowered and the irregularity abolished with quinidin, or in which the pulse rate can not be lowered and held within bounds by rest and digitalis or its allies, offers but a gloomy prognosis.

Quinidin Sulphate. That quinine and quinidin can slow the heart was known at least as early as 1853, for Briquet records this observation in his work on Cinchona. He found this true both in animal experiment and in patients with various diseases. The amount of slowing was not great ordinarily because he was dealing with patients having a regular rhythm. That quinine and its sister alkaloid, quinidin, can sometimes abolish auricular fibrillation has been known but a short time. In 1914 Wenckebach[61] succeeded in abolishing auricular fibrillation and restoring normal rhythm by the use of quinine. Inspired by this work, in 1918 Frey,[62] experimenting with the various alkaloids of quinine, fixed upon quinidin sulphate as the more desirable remedy for abolishing auricular fibrillation. Since then, series of cases have been reported by Levy,[63] Drury and Iliescu,[64] Wolferth[65] and many others. All observations are more or less in accord that quinidin, properly administered, will abolish fibrillation and restore a normal rhythm in about fifty per cent of cases. The regular rhythm will endure for several hours, days or even months. It is too early to know whether the persistent use of small amounts

of quinidin will succeed in holding the regular rhythm in many cases.

Method of Using Quinidin. The patient should be free from digitalis and strophanthus before beginning the treatment. Roughly, a patient will excrete from fifteen to twenty minims of tincture of digitalis in twenty-four hours[66]; if he is receiving a dram of the tincture in twenty-four hours, he is temporarily storing about forty minims, during that time. An estimation of the amount he has received and stored and the knowledge that it takes a store of about five to six drams to produce the full physiologic effect, gives an index of the time that should be allowed to free him.

One or two doses of three grains (0.2 grams) each of quinidin sulphate, should be given in capsule to see if the patient has any idiosyncrasy. An electrocardiogram should be taken before beginning treatment and again when the regular rhythm seems to be established. Of course the ideal method, especially in the early studies of this reaction, is that of Drury and Iliescu. They took direct leads, every two hours, from the chest wall directly over the heart, where the oscillations are maximal. Thus they secured a good average count of the frequency of the oscillations, which means the auricular rate, and also a means of determining a good ventricular count.

Naturally, many cases will have to be treated without these refinements. The patient should be kept in bed or at least in the room, and the quinidin sulphate should be administered the first three days thus:

1st day—8 A.M., 12 M., 4 P.M., grains 6 (0.4 grams).
2d day—8 A.M., 12 M., 4 P.M., 12. Midnight—grains 6 (0.4 grams).
3d day—8 A.M., 12 M., 4 P.M., 12. Midnight—grains 6 (0.4 grams).

In the successful cases the reaction will often appear during the second or third day. If there has been no reaction, and the patient shows no marked acceleration of pulse and no other undesirable symptoms, the treatment may continue.

4th day—4 A.M., 8 A.M., 12., M., 4 P.M., 8 P. M., Midnight—grains 6 (0.4 grams).

On the fifth and sixth days the same dosage as on the fourth day may be continued, if there is no reaction. By

this method, at the end of the sixth day, the patient will have taken 11.6 grams of quinidin.

Ordinarily, in the successful cases, the reaction will appear before this point but it has come only when larger amounts have been taken. With this dosage beyond the sixth day, unless one is taking direct leads, it is probably better to reduce the dosage to six grains (0.4 grams) four times in twenty-four hours.

In all cases direct leads show a more or less progressive slowing of the auricular rate and that the maximal influence of each dose of quinidin is exerted at the end of two hours; after that, the rate begins to rise. For this reason it is advised to give one or two doses at night; neglect of this precaution caused failure several months ago in a case which was completely successful later. Clinical cases of fibrillation by these exact methods show auricular movements varying from three hundred to six hundred, with an average of four hundred and fifty, per minute. Under treatment the rate progressively falls and in successful cases, there is an abrupt termination of the irregular rhythm and the recurrence of the normal rhythm when the auricular rate reaches a point somewhat above two hundred. It is undesirable to slow the rate below two hundred, for at these lower rates the ventricle often attempts to keep pace with the rapid auricular impulses, which leads to an undesirable rapidity of ventricular rate. The electrocardiographic curves taken by these direct leads show the following characteristics: The intersystolic periods showing no oscillations diminish; as the auricular rate slows, the oscillations become more regular, in time and form they are like impure flutter, rarely one ends in pure flutter. The only symptoms complained of by patients during treatment, and this is by the minority, are transient attacks of palpitation, occasional headache, and an occasional fainting fit. A patient of mine apparently experienced the latter while in bed but on recovery she discovered that her pulse was regular. Perhaps in this case the ventricular rate had temporarily tried to follow the auricular rate. The successful and unsuccessful cases do not seem to fall into any special groups. Naturally, one would expect that the young, rheumatic cases, especially those with mitral

stenosis, would more often yield to treatment. There are not enough statistics yet to pass upon this point. Cases past middle life, with a history of rheumatism many years before, sometimes give a perfect reaction.

Evidently we are dealing with a powerful remedy, whose effects are striking, and which must be used with discretion. It is not possible to bring every patient into contact with an electrocardiograph and to secure direct two-hour leads when one does. The question arises, what precaution must we observe in using this remedy without the help of exact methods? First of all, let the patient be confined to bed, or at least on the second and third days, when there is reason to expect a change in mechanism. See that the patient has no idiosyncrasy, and be guided in dosage by the suscepti- bility of the patient, as to whether there is evidence of cin- chonism or marked increase in pulse rate. It is rarely neces- sary to exceed the dosage given above, though where no re- action is obtained and the patient shows no untoward symp- toms, three or four doses daily may be kept up several days longer. In successful cases the quantity of quinidin sulphate necessary to give a reaction has varied from one to ten grams, with an average of about four or five grams. At the end of the first day an increase in ventricular rate of from thirty to forty beats per minute is to be expected. This is due to two causes: First, as the auricular rate falls, conduction automatically rises and more impulses are transmitted to the ventricle. Second, quinidin has a weaker but similar influ- ence to atropin upon the vagi; it depresses their function which tends to increase the ventricular rate. Again, from the second day on, one expects to find a pulse rate of from ninety to one hundred and twenty in these patients during treatment. It varies, but in any case it will remain higher than was the average rate before treatment. A sudden jump in the ventricular rate to one hundred and fifty or above will immediately imply the necessity of reducing or discon- tinuing the quinidin, as in all probability the auricular rate is approaching two hundred and a one-to-one rhythm is attempting to form.

How Quinidin Sulphate Slows the Heart in Auricular Fibrilla- tion. The remarkable action of quinidin sulphate in auricular

fibrillation, and its possibilities, at once arouse an interest as to how it acts. Lewis[67] again does us a service in showing how its action is in accord with the present conception of auricular fibrillation. As we have seen, quinidin slows the auricular rate in all cases of auricular fibrillation. In the successful cases, the disordered auricular action suddenly terminates and the normal rhythm returns. First of all it is necessary to review the mechanism of auricular fibrillation as now understood. As already pointed out, this disorder of the heart is due to a circus movement, a single excitation wave perpetually revolving around the same auricular muscle path at an average rate of four hundred and fifty per minute. It is this wave that controls the auricular beat and not the individual impulse arising in the sinus at a rate of from seventy to eighty per minute, as in the normal mechanism. Now, that a circus movement may exist, three things are necessary: a sufficiently short refractory period, a sufficiently slow rate, and a sufficiently long circular path in the auricle. Reflection will show that an excitation wave revolving continually in a circle of auricular muscle, constantly leaves in its wave muscle tissue in a refractory state that needs time to recover its excitability. That the wave may continue it is necessary that there should be a gap between the "crest" and the "wake" of the wave. It is in this gap of the circular path that muscle is resting and regaining excitability, so that the oncoming wave finds a reëntrant place in the ring. The slower the rate of the wave and the longer the circuit, the more time is allowed the refractory gap to recover its excitability. It has been shown by experiment that in auricular fibrillation this gap is short. In quinidin a remedy has been found which closes the gap. It closes it by prolongation of the refractory period; the circulating wave finds its reëntrant path obstructed and comes to an end. This happens in fifty per cent. of cases, and with the end of the circus movement, the sinus again gains control. This explains the action of quinidin in the successful cases, but the action of the drug is not so simple. It not only prolongs the refractory period in the auricle, which tends to abolish the circus movement, but it also slows auricular conduction, which favors a reëntrant point in the circle by pro-

longing the gap. Therefore, quinidin has two and opposite effects, and its action in any fibrillating heart will depend upon which predominates. Where its action in prolonging the refractory period is greater than its slowing of conduction, the circus movement will terminate. Where the second action is greater than the first, or where they are equal, the drug fails to act. Thus it is in the unsuccessful cases. However, in the unsuccessful cases, direct leads from the chest show that there is an auricular slowing which is probably due to depressed conduction in the auricle. Clinically, during the first twenty-four hours of the treatment, there is always a rise in ventricular rate of from thirty to forty beats per minute. This is due to two factors: one is a fall in auricular rate, which is automatically accompanied by lessened block and increased ventricular rate; the second factor is due to the fact that quinidin depresses the vagus—it has the same effect as atropin but its action is less marked. Of course, this depression of the vagus also increases the ventricular rate, but this increase in the heart rate is modified by the fact that quinidin depresses the function of the junctional tissues.

Paroxysmal Fibrillation. Short paroxysms of fibrillation do occur and the question of treatment is so important that we may consider the subject briefly here. These transient attacks may last a few minutes, hours or days, and exact methods alone may distinguish them from regular paroxysmal tachycardia. They are strongly in contrast to the ordinary auricular fibrillation which is essentially a chronic and often a terminal irregularity of the heart. They sometimes arise during severe attacks of acute infections. I have seen them in pneumonia, intermingling in a case of arteriosclerosis with attacks of simple tachycardia, and in mitral stenosis these attacks have come and persisted for several days at a time, and yet two years after the beginning of such attacks the auricles have not passed into permanent fibrillation. The question that arises is, when shall we give digitalis in such cases? because it is known that in patients predisposed to fibrillation, digitalis will precipitate it. This drug, then, is ordinarily contraindicated in patients showing short paroxysms of fibrillation, but where the fibrillation persists

for a fortnight, digitalis therapy may be instituted as in the chronic variety. Even in the short paroxysms where the pulse rate is extremely high and the patient in jeopardy, one need not hesitate to use strophanthin intravenously or large doses of digitalis.

Alternation of the Heart.

Pulsus alternans is a condition in which strong and weak pulse beats alternate, but in which the cardiac rhythm is normal. A regular auricular beat is followed by a regular ventricular beat, but each alternate contraction of the left ventricle throws a larger and smaller quantity of blood into the systemic circulation. The cause of alternation of the pulse is not clear, but it has been suggested that an unequal number of ventricular fibres contract at alternate systoles. Alternation may be constant or it may be seen after premature beats only. Where the pulse is coupling and the premature beats are late, the condition suggests alternation. There is another form of pseudoalternation, which is due to respiratory blood-pressure changes.

Conditions With Which Associated. Alternation is comparatively common in cases where there is remarkable acceleration of the pulse, as in paroxysmal tachycardia, and auricular flutter. But more important from the clinical point of view is alternation with a pulse rate near the normal or but slightly accelerated. The condition is commoner in males, from fifty to seventy years, though I have seen it well marked at fifteen years. (Fig. 45.) It is a common finding among office- and out-patients with marked hypertension, whether it be arteriosclerotic or essentially renal. It is common in angina pectoris and in those who, on physical examination, show definite cardiac enlargement. It is sometimes found during digitalis administered. White[68] found that in cardiac patients showing any degree of decompensation, alternation occurred in thirty-three per cent. of patients. He found it seventy-one times among three hundred cardiac and cardiorenal patients examined. It occurred as frequently as fibrillation in his series. Its presence always means a heart muscle temporarily, or more often permanently, overburdened.

Determination of Alternation. Occasionally, it may be recognized by palpating the radial. Examination of the apex is not satisfactory, as variability of the sounds is not sufficient for making a clear diagnosis. A strip of radial pulse tracing is usually the most satisfactory method of diagnosis. (Fig. 46.) The alternate variation in the amplitude of the pulse beats may be confounded with coupling, due to premature beats, where the latter occur late. In the premature beat, the longer pause follows the pulse beat of smaller amplitude. In alternation, the shorter pause occurs after the small beat if the two intervals are unequal. In alternation, the interval between the beats is equal or almost equal ordinarily, but where they are unequal the longer interval is between the up stroke of the large and the up stroke of the small beat.
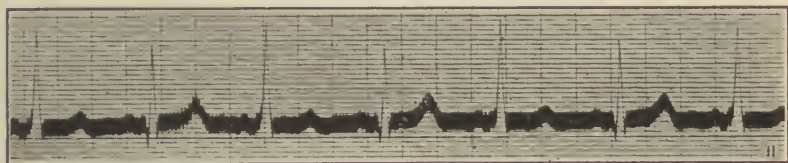
Fig. 45.—An electrocardiogram showing alternation in a boy with congenital heart disease.

Alternation may also be diagnosed by the blood-pressure apparatus. In a hypertension case with a regular pulse rate of eighty the radial pulse rate may drop to forty at one hundred and eighty millimeters of mercury and remain at that rate until two hundred is reached, when the pulse entirely disappears; or taken in the reverse order, at two hundred millimeters the radial pulse is lost. From two hundred to one hundred and eighty, the strong beats come through at the rate of forty; below this the regular rate of eighty returns but the new beats are weaker than those coming through at two hundred. The stethoscope over the artery plainly detects this condition. Where the difference in millimeters of mercury between the beats is small, alternation may be picked up by the use of the sphygmomanometer,[69] even before it is detected in the curves of a sphygmograph.[70] A difference of six millimeters of mercury and above between the beats is recognizable in ordinary radial pulse

tracings. The method of detecting alternation of the pulse
by the auscultatory blood-pressure method is satisfactory in
cases of constant alternation. It is unsatisfactory in alter-
nation which follows premature beats and these constitute
the majority of the cases. In the latter type the radial pulse
tracing is far more satisfactory. Alternation and bigeminy
are differentiated best by the electrocardiograph.

Electrocardiographic records are not so satisfactory as
arterial tracings in the diagnosis of alternation. It may be
present in the latter and not in the former, or the reverse
may be true. When present in the electrocardiogram, alter-
nation shows best in the R-S deflections, Fig. 45. Occasion-
ally, T shows some variation. It is often flat or inverted,
even where the patient is not taking digitalis. Sinus ar-
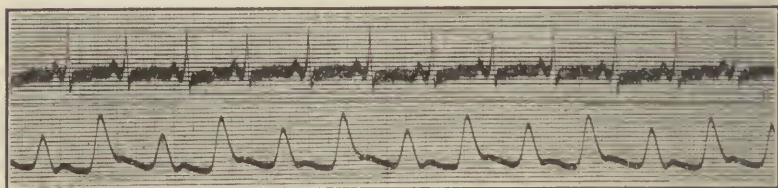
Fig. 46.—Simultaneous electrocardiogram and radial curve from a
patient with constant alternation, which is not in evidence in the
electrocardiogram but well marked in the pulse.

rhythmia occurs frequently in the curves. Ventricular pre-
ponderance, especially left, is common in these curves and
a large percentage show some defect of the A-V conducting
system.

Symptoms. The symptomatology in alternation is due en-
tirely to the associated conditions. Dyspnea is common,
especially at night; some of these patients complained of
awakening in the early morning hours with shortness of
breath and short attacks of palpitation. This is more apt to
occur after some unusual physical or mental strain and the
following morning I have found moist râles in the bases of
the lungs and alternation present. One patient in particular,
who had recurrent attacks of acute pulmonary edema two
years ago, now immediately has recourse to digitalis, with
the result that he usually has only one attack, though he has

fairly constant alternation. He has an enlarged heart secondary to chronic nephritis.

Prognosis. Alternation is of bad prognostic significance; other symptoms of heart failure may be present but alternation often stands alone as the danger· signal. Alternation following premature beats only, when marked, shows practically the same mortality as the constant form. Frequently post premature beat alternation tends to pass into constant alternation; furthermore, even when alternation is the only constant sign of myocardial weakness, these patients usually have a poor exercise tolerance. Usually a few months or a year or so, terminate the life of the patient. The only optimistic element in a given case is where the patient has been under heavy strain and the alternation entirely disappears under rest; sometimes patients lose this unfavorable sign under the use of digitalis.

Treatment. Since pulsus alternans means an overtaxed heart, the indications for rest, both physical and mental, are self-evident. The manual worker must shorten his hours or change his work. The brain worker needs a let-down in nervous and emotional tension. Contrary to earlier beliefs, digitalis seems to do good in many of these patients. With increasing experience, we have learned to look upon the heart as a whole and no longer say that heart block, premature beats, and alternation, are always contraindications to the use of digitalis. A failing heart that does not respond to rest, should lead us to try digitalis, whether the rhythm be regular or irregular.

Sinus Disturbances.

We have seen that in the normal rhythm impulses arise in the sino-auricular node at an average rate of about seventy per minute, traverse the auricle and the auriculo-ventricular connecting system, and cause a ventricular beat to follow each auricular impulse. The rate at which the sino-auricular node generates and discharges impulses is influenced by the vagus. Increased activity of this nerve tends to slow the rate, while decreased activity is accompanied by an increased heart rate. An injection of atropin

paralyzes the peripheral ends of the vagus and a marked increase in the pulse rate follows, perhaps one hundred and fifty per minute being the maximum. It has largely the same effect as section of the vagus. The predominant influence of the vagus is inhibition of the heart rate; it may exert its influence constantly, which leads to a marked slowing of the beat, or the mean vagal tone may constantly vary, leading to a gradual increase and decrease in the heart rate. *Sinus irregularities* fall naturally into the respiratory and the non-respiratory. On deep inspiration the pulse quickens; on expiration, it slows; sometimes a long pause follows the expiratory period.

Respiratory Arrhythmia. In children respiratory arrhythmia is the commonest cause of irregularity of the heart; it is present from birth, is marked during the first ten years,
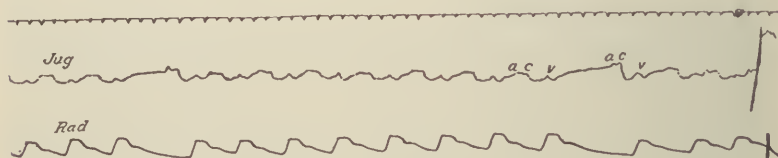
Fig. 47.—A tracing showing intermittent slowing of the whole heart in the jugular and radial pulses. There is also variation in the length of the radial beat. It is a sinus arrhythmia from the same patient as Fig. 48.

and is very conspicuous at the time of puberty; this same type of irregularity may be induced by deep breathing, even in many adults. This form of arrhythmia sometimes persists in the second and third decades, especially among those with unstable nervous systems. Irregularity distinctly associated with respiration is vagal because atropin always abolishes it. Although this type of breathing occurs most commonly in the healthy, it may occur during convalescence from acute fevers. In respiratory arrhythmia the irregularity affects the whole heart, the venous curves will show *a, c, v* waves, and the electrocardiogram the natural *P, R, T* complexes. (Figs. 47 and 48.)

Sinus Irregularity Not Associated With Respiration. This group of sinus irregularities is comparable to the effects produced by stimulating the vagus by an electric current. We

have already seen that weak stimulation of the right vagus produces slowing of the whole heart, and that transition in rate from faster to slower is gradual; also that with the cessation of stimulation the slower rate quickens but gradually. With stronger stimulation of the right nerve, a standstill of the whole heart is produced.

Again, especially when the left vagus is stimulated, auriculo-ventricular heart block may be produced. Conduction through the *A-V* node is depressed by this means.

Included among the non-respiratory sinus abnormalities[71] are: (1) Phasic or periodic irregularity of the pulse. Phases of rapid and slow heart action may alternate or a natural rate may be disturbed periodically by phases of slow action lasting a few seconds. The changed mechanism develops gradually. It is seen in those convalescent from acute fevers, in digitalis administration, and also after exercise.
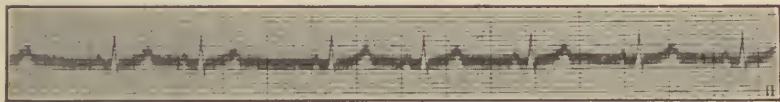
Fig. 48.—Electrocardiogram from the same patient as Fig. 47, each beat shows normal *P, R, T* complexes, but there are varying diastoles due to sinus irregularity.

(2) Prolonged slow action of the heart. This has already been considered under the head of bradycardia. As has been said, the pulse rate of the healthy young adult at rest averages seventy; the limits of normal pulse rate vary from fifty or sixty to one hundred, or even one hundred and ten. Occasionally one sees a healthy young adult in the third decade who constantly shows a pulse rate of fifty to fifty-five; they also at times show sinus arrhythmia.

(3) Standstill of the whole heart. This may occur under the influence of digitalis, the whole heart ceasing to beat for at least two seconds. Similar cases have been recorded where a tumor compressed the vagus. Laslett[72] reported a patient with no signs of cardiac disease who showed standstill of the whole heart of from four to eight seconds duration associated with syncope. Atropin abolished the attacks in this patient.

(4) Prolonged slowing of the heart, associated with a fall in systolic blood-pressure. This is the commonest cause of fainting attacks, such as are produced by long standing in overheated rooms, by emotion, or some harrowing sight. It is a reflex vagal effect. The subject first notices a little swimming in the head, and blurring of vision. Pallor and sweating, nausea, vomiting and unconsciousness, sometimes muscular twitchings, follow in quick succession. The heart slows to forty or fifty and the systolic blood-pressure falls to sixty, sometimes a little lower. This fall in blood-pressure is independent of the pulse rate. The slow pulse is at once abolished by atropin. This condition is frequent in neuro-circulatory asthenia, in nervous women, and in those who have recently had an acute illness or who are chronically in poor health.

(5) Several forms of vagal disturbance may coexist, namely, sino-auricular slowing occurs in heart block, and respiratory arrhythmia and phasic variations may occur in the same patient. The same irregularity may be associated with respiration at one time and independent at another.

Sino-auricular Block. This is an infrequent form of pulse irregularity which is not well understood, though sometimes it is clearly of vagal origin. It appears during digitalis administration and is often associated with auriculo-ventricular heart block. It reveals itself in one or two ways: either by an intermittence of the whole heart, or by a sudden fall in heart rate. When a single heart beat is lost the long pause is usually somewhat shorter than two beats of the natural rhythm, and when the heart rate slows there is an abrupt passage from the one rate to the other. The slow rate approximates half the former rate, but it is rarely exact.

Sino-auricular heart block is also supposed to be one cause of slow action of the whole heart. The only theory put forth to explain S-A block is, that there is delayed conduction between the sino-auricular node and the main mass of the auricular tissue. The electrocardiographic curves show normal auricular and ventricular complexes.

The Diagnosis of Sinus Irregularities. An irregular pulse during childhood, also during puberty, especially if influenced by respiration, is almost always due to a sinus irregularity.

Sinus irregularity may be brought out by deep breathing. A gradual increase and decrease of pulse rate, especially if recurring, is always suggestive. The apex beat and the pulse beat correspond. The heart sounds are normal but the diastoles vary. All vagal irregularities tend to disappear with a marked increase in pulse rate; thus, exercise, amyl nitrite or atropin, abolish this form of irregularity.

Prognosis in Sinus Irregularity. The only forms of prognostic significance are those accompanied with syncope and, perhaps, the pulse rate showing true periodic variations. Sinus irregularities are common from birth to puberty and are not uncommon in young adults with a nervous temperament. The inhibitory action of the vagus apparently varies under influences but little recognized. Particularly in children sinus irregularities are negligible. Ordinarily, neither in childhood nor in adults do they call for special treatment.

Sensory or Symptomatic Disturbances.

The sensory or symptomatic disturbances of the heart will be briefly discussed under the heads of Cardiac Consciousness, Cardiac Pain, Palpitation, and Effort Syndrome or Neuro-circulatory Asthenia, as classified by Osler and McCrae.

Cardiac consciousness, or distress or pain, may be present where there is no sign of organic heart disease. Often the background is nervous, sometimes the endocrine glands are at fault, chronic infections or metabolic poisons, are among the causes and in some patients there is real cardiac disease, especially myocardial. Whether these patients have or have not heart disease is often hard to say. They constitute symptom complexes rather than diseases. As already stated, though the heart has many intrinsic nervous ganglia, we are ignorant of their function.

Heart consciousness is the mildest form of cardiac distress. Nervous exhaustion—temporary or permanent—from overwork, over-worry, anemia or other disease, leads to heart consciousness. The heart mechanism is perfectly regular but the patient is aware of it. While in health he is unconscious of his heart action. Patients are frequently aware of it on retiring.

Cardiac pain is the next step in cardiac distress. It may be located at the apex or it may cover wider areas of the chest wall. The more definitely substernal it is, the more important it is, for then it is often associated with aortitis, aneurism, aortic valve disease and grave angina pectoris. Exertion aggravates this pain, whether it be due to nervousness or whether it be a genuine anginal pain. In genuine angina the patient usually has little pain when at rest, whereas the nervous form of cardiac pain is often worse when the patient is quiet, especially at night. Among the causes of cardiac pain are: pericarditis, valvular disease—especially aortic—and the grave form of angina pectoris. It occurs also reflexly in digestive disturbance, and from toxic substances like tobacco, in cardiac dilatation, and in simple paroxysmal tachycardia. It may occur in myocarditis where the pulse is regular.

Diagnosis. Any cardiovascular disease should be diligently sought out. The patient's nervous system should be carefully examined. Hyperalgesia of the skin and of the muscles of the chest is commonly found in patients with cardiac pain, whether functional or organic. Grave cardiac pain is commoner in middle life or later, is more often felt after exercise, and the heart more often shows structural disease. The less serious form occurs in younger and nervous subjects, often when at rest. Observation of the patient is more important than his statement in assessing the value of cardiac pain. In the so-called functional type of cardiac pain, nervous sedatives are indicated. Angina pectoris is discussed elsewhere.

Palpitation. There is a divergence of opinion as to what definitely constitutes palpitation. Osler writes: "The term is properly limited to irregular or forcible action of the heart perceptible to the individual." It is common in extra systoles, when the patient is conscious of the large beat following the premature. It is experienced during rest, especially after exercise. It is sometimes due to paroxysmal tachycardia and auricular fibrillation, but in more patients it is caused by rapid, forcible, regular heart action. These patients show an increased excitability of the nervous system, therefore it is common in neurasthenia, in hysteria, in emotional excitement, including fright. It is commoner in women, es-

pecially during menstruation, at puberty, and at the meno-
pause. It may be due to over indulgence in tobacco, alcohol,
coffee, and tea, or to hyperthyroidism. More often it is
simply due to nervous causes, but occasionally it may be
associated with organic diseases of the heart.

Symptoms. The patient is conscious of a rapid or tumultu-
ous action of the heart, often with a sense of great distress.
The pulse rate may run as high as one hundred and fifty,
but occasionally the patient may have palpitation without
any quickening of the heart rate. The attacks usually last
but a few seconds or minutes, but sometimes they last longer.
Where due to extra systoles exercise may bring relief, espe-
cially in young individuals. Some of these patients suggest
early mitral stenosis, so that an effort should be made to
force out a diastolic murmur.

Diagnosis. The nervous system, the gastrointestinal tract,
the thyroid gland, and the condition of the blood, should be
considered. If any one of the removable causative factors
can be found and there is no concealed heart disease, then
the outlook is good.

Treatment. Consideration of the mental state is import-
ant, as palpitation is common in certain neuroses, including
sexual disturbances. A modified rest cure, including hydro-
therapy, is necessary in many of these cases. Alcohol, to-
bacco, tea, and coffee, are undesirable. Restriction of food,
so as not to cause flatulence, is necessary. Sleep should be
secured by mild hypnotics. Osler recommends especially
iron and nux vomica, the latter in ascending doses.

The Effort Syndrome.

This condition has been variously called the irritable heart,
the soldier's heart, disordered action of the heart, and neuro-
circulatory asthenia. It is a combination of symptoms which
includes breathlessness, early fatigue and exhaustion on effort,
precordial pain, and vasomotor disturbances, as fainting, ver-
tigo, headache, and sweating. Originally studied among sol-
diers, it is now recognized in civilians, men, women and chil-
dren being affected. Some show constitutional weakness, both
physical and nervous, sometimes the condition is secondary

to exhaustion following over-work, worry and loss of sleep. It may follow in the wake of infectious diseases or be the expression of an unrecognized infection. In some there is actual incipient heart disease. Balfour[73] long ago recognized that people with long narrow chests are prone to cardiac disturbance, especially to increased pulse rate. In effort syndrome this type of patient with dropped heart and general ptosis is common. Hyperthyroidism occurs in a small number of cases. Nervous symptoms are often in the foreground. Neuro-circulatory asthenia has occurred after acute rheumatic fever, pneumonia, tonsillitis, influenza, focal infections, repeated pregnancies at short intervals, and some so-called postoperative neurasthenias suggest this type. Syphilis is an unimportant factor.

Symptomatology. Breathlessness on exertion is common. No structural lesion of the heart or cyanosis or renal involvement is present to explain it. Pain in the region of the precordium, without definite radiation and aggravated by exercise, is common. Hyperesthesia of the skin and muscles in the same region is usually present. Fatigue and exhaustion entirely out of proportion to the effort put forth characterize this complaint. There is an instability of the vasomotor system, as is evidenced by fainting, vertigo, and headache, among these cases. Profuse sweating in the axilla and of the hands and feet, also coldness and flushing of the extremities, are common. One was struck with the frequency of chilblains, involving almost always the fingers, among the personnel of the navy at Brest in the winter of 1917-1918. They were commoner among the as yet unhardened reservists after a bout at mine sweeping, coastal convoy, or torpedo-boat convoy. Most of them also had suffered from the almost universal attacks of laryngitis, tracheitis, and sometimes bronchitis, to which all new-comers were subject. Some of these showed the stigmata of neuro-circulatory asthenia and among these the chilblains were not uncommon. Any marked evidence of local asphyxia of the fingers was not seen.

The heart rate is usually above normal. In some cases it may run one hundred and twenty or above, and in exercise tests these patients are apt to give a sharp rise in heart rate and a slow return to normal. The blood-pressure

does not show any characteristic changes. No structural disease of the heart ordinarily can be demonstrated; however, some cases of mitral stenosis may be confused with the irritable heart, so that all tests spoken of under mitral stenosis used to force out an indistinct diastolic murmur must be tried. The symptoms and signs, then, are largely those found in normal persons after excessive exercise. The striking thing about this syndrome is the very slight physical effort which suffices to produce the complex in the individual. A functionally impaired nervous system, whether the impairment be permanent or transient, is an important element in these patients. In some it appears congenital, in others the etiologic factor lies in over-work, physical or mental, in worry, or in convalescence after acute disease. The *treatment* consists first of all in finding the cause and removing it if possible. Good food, good hygiene, including care of the skin and teeth, and especially graded exercise in the open, under supervision, work wonders in these men. Naturally, those who appear to have originally a fairly well balanced nervous make-up show the most rapid and complete recovery.

ENDOCARDITIS.

Endocarditis may be classified as acute, including the simple and the malignant forms, subacute bacterial, chronic infective, and chronic sclerotic. In endocarditis, the inflammatory process is largely confined to the valves, but there may be also involvement of the mural endocardium.

ACUTE ENDOCARDITIS.

Acute endocarditis is almost always secondary to some infective process. The division into simple or benign, and malignant or ulcerative, is for convenience only. These forms are but different degrees of the same pathologic process.

Causes. Simple endocarditis is especially associated with rheumatic fever, also with tonsillitis, chorea, scarlet fever, typhoid fever, and tuberculosis; it is rare in diphtheria; it may occur in nephritis, gout, diabetes, and cancer as a terminal process. In some of these the cause may be a chem-

ical irritant primarily rather than an infection. The simple endocarditis of such conditions as typhoid may not be due to the specific microbe but to another infection.

Malignant endocarditis is often associated with pneumonia, though the simple form also occurs in this disease. Preble[74] found that about twenty-five per cent. of all cases of bacterial endocarditis were due to the pneumococcus, and that endocarditis complicates pneumonia in one per cent. of all cases and five per cent. of the fatal cases. Gonorrhea is not an uncommon cause, as pointed out in 1905 by Thayer,[75] who was among the first to demonstrate the microörganism in the blood. Puerperal fever, erysipelas, and septic processes in general may be the sources of infection. Both the simple and the malignant forms may occur upon old sclerotic valves. Endocarditis is said to be common in the valves in congenital lesions; almost always secondary, it is perhaps rarely primary.

Morbid Anatomy. Simple endocarditis is characterized by the formation of verrucose vegetations; malignant endocarditis by these vegetations plus necrosis and ulceration; the sclerotic form by chronic valvular disease. In simple endocarditis these vegetations are found on the affected valves and also on the mural endocardium, if it is involved.

Infective endocarditis, in adults, involves usually the left side of the heart, while in the fetus it involves the right side, so that simple endocarditis is found more commonly on the left side, usually involving the mitral valves oftener than the aortic valves. Ordinarily, the vegetations are along the lines of closure of the valves. When young, they are composed of blood platelets, leucocytes and fibrin. They are invaded by the proliferating endothelium and subendothelium and later are transformed into connective tissue. The vegetations may enmesh bacteria, but these are much fewer in the simple form than in the malignant form of endocarditis. They may be found only on section and staining and then may be few in number. The results of this so-called benign inflammation of the endocardium, which is usually confined to the valves, may be occasionally a tendency toward healing, or it may terminate in the ulcerative form of endocarditis. Again, even when the

vegetations disappear, the affected valve is left sclerosed
and deformed.

In *malignant endocarditis,* the vegetations are more prolific
and there is necrosis, ulceration and sometimes even per-
foration of valve, ventricular septum, or heart wall itself.
Besides, bacteria are much more numerous than in the sim-
ple form. The parts involved are, in order of frequency, the
mitral valves, aortic valves, mitral and aortic together, pul-
monary valves, and in many of these cases there may also
be some involvement of the mural endocardium. The upper
part of the septum in the left ventricle and the posterior wall
of the left auricle are favorite spots. The right heart is much
more often involved than in simple endocarditis. The in-
flammatory process may extend into the aorta and the pul-
monary artery causing well marked endarteritis. Embolism
is common in this form of endocarditis. Emboli may lodge
in the meninges or in the brain itself, causing hemiplegia;
in the kidneys, causing bloody urine; in the spleen, causing
enlargement and pain in that region; in an extremity, caus-
ing gangrene; and in the lungs, especially in right sided endo-
carditis. Retinal hemorrhages may occur.

Bacteriology of Endocarditis. The two forms of endocar-
ditis under discussion can not be distinguished by any dif-
ference in bacteriologic findings, except that they are less
frequent and less virulent in the simple form. Pneumo-
cocci, streptococci, staphylococci and gonococci are the most
frequently found. The staphylococcus infections may be
traced to the skin, as in furunculosis, carbuncles or felons.
The pneumococcus may be responsible for simple, malignant,
or as pointed out by Billings,[76] the chronic infectious form
of endocarditis. The transmutation of one type of strepto-
coccus into another, in Rosenow's[77] experiments, and the
change in their pathogenicity, is interesting in this connec-
tion. Especially so is the selective tendency of these organ-
isms for particular tissues in the body. Thus, the virulent
type of pneumococcus tends to involve the lungs, while the
less virulent type of the same organism has selective ten-
dencies similar to the streptococcus viridans, *i.e.,* for the
heart. Meningococcus septicemia was recognized by Gwyn[78]
in 1899, and Cecil and Soper[79] report meningococcus endo-

carditis with septicemia in 1911. Endocarditis has been found
in influenza, and the colon bacillus has also been isolated.
That the *Streptococcus viridans* is a common cause of endo-
carditis we shall see under the heading of the Subacute
Bacterial Form.

Symptoms and Signs. *Simple endocarditis* is frequently a
latent process and found at post mortem only. In adults,
with marked vegetation, the conditions may occasionally be
afebrile, but this is rarely true in children. Slight prolonged,
continuous fever is frequent. The fever of the complicating
disease may increase with the development of endocarditis.
Recurring endocarditis on old sclerotic valves of mitral or
aortic disease may be marked only by a period of fever, oc-
casionally with transient myocardial insufficiency as well.
In rheumatic fever the recurrence of fever during convales-
cence, with no return of joint symptoms, should arouse sus-
picion of endocardial involvement. In children, fever is a
far more constant symptom than in adults. Pain is uncom-
mon in primary attacks; it is common in old recurring, sim-
ple endocarditis, where it may be paroxysmal; precordial
distress and hyperesthesia are common. In simple endo-
carditis, sweats, especially at night, are fairly common; heavy
chills, comparatively rare. The pulse is rapid but not char-
acteristic, as its rapidity may be due to the primary disease;
as the commonest site of acute endocarditis is the mitral
valves, the systolic murmur—heard best at the apex—is im-
portant. This is especially true if it has developed under
observation from a mere systolic roughening progressing
even to harshness. If it persists, whether the patient is
standing, sitting or recumbent, and is present at each ex-
amination, it is probably genuinely organic. Such a murmur
may increase during convalescence. Aortic valve disease
may be even more difficult to recognize, and the diastolic
murmur due to aortic incompetence often becomes satisfac-
torily evident only during convalescence.

Leucocytosis, according to Rosenow,[80] may not be found
before the stage of ulceration, and may not be present when
a large number of bacteria are in the blood. The inflamma-
tion of the endocardial membrane may be sufficient to cause
fever and even suggest endocardial change, but there may

not be as yet enough intoxication to incite leucocytosis. The diagnosis rests upon the symptoms and signs above enumerated.

Malignant Endocarditis. This is the group with suppurative lesions. There is a septic and a typhoid type, and in the septic type there is often a site of local infection, as a wound, necrosis, septic uterus or gonorrhea. Repeated chills are common, as are also heavy sweats; fever is marked and it may be remittent, sometimes high and continuous; there is progressive wasting and anemia and embolic features are common, involving spleen, kidney, brain, meninges, lungs and other organs. There may be no special cardiac symptoms or signs, but on the other hand murmurs may develop or change in character and myocardial involvement may lead to dilatation. In the typhoid type there are no suppurative lesions. The fever is irregular and may last from three weeks to three months; all of the symptoms may suggest typhoid fever; blood culture may be helpful; occasionally, embolism may fix the diagnosis, but it is rarer in this form. Malignant endocarditis may simulate meningitis. This is the so-called cerebral group in which the patient may be comatose or delirious. The cardiac group is practically synonymous with recurrent endocarditis. In the recurrent form patients with old chronic mitral or aortic disease develop fever, sometimes remittent but at least persistent, which may run for weeks or months. The signs and the local lesions may grow worse and occasionally embolism may determine the condition. Again, these attacks are attended by but little fever, but even where it is most marked the patient may recover. The diagnosis in the malignant type rests upon the primary disease. A local focus of infection, pneumonia or gonorrhea, may suggest a possibility. Petechial rashes, evident new valve lesions, blood culture and embolic features are important points.

In the nonsuppurative group, the diagnostic points are: that these patients are the subjects of old valve disease; that the fever is persistent; that the disease simulates typhoid, tuberculosis or malaria.

Prognosis. The immediate outlook in simple acute endocarditis is favorable; the fatal outcome is to be anticipated

only if severe myocarditis and pericarditis accompany the endocarditis. Complete recovery in the benign form of endocarditis probably rarely occurs; in certain of these cases ulceration of the valve may occur; in any case, the valve is apt to suffer some functional impairment, which may result in more or less incompetence or stenosis. Thus a persistent murmur may arise even long after convalescence. The course of endocarditis varies also with the character of the infective agent; staphylococci and gonococci are apt to cause a short malignant course, lasting only a few weeks; the fatal termination in streptococcus infection is none the less certain but the duration may be longer.

Naturally, the prognosis of ulcerative endocarditis is always grave. It usually terminates in death. Recurring endocarditis and the subacute forms offer a more hopeful outlook.

SUBACUTE BACTERIAL ENDOCARDITIS.

Schottmüller,[81] in March, 1910, described an endocarditis lenta, due to the Streptococcus viridans. Libman,[82] about the same time, reported his cases of subacute bacterial endocarditis due to the same microörganism. Rosenow,[83] by subjecting bacteria to varying oxygen pressure in culture media, was able to change their characteristics. He describes three strains of organisms, whose characteristics he can change culturally so that each has a marked affinity for certain structures. These are a hemolytic streptococcus which has an affinity for the joints, a *Streptococcus viridans* for the heart valves, and a third one which also has an affinity for the joints. This change in virulence and selective action on the part of bacteria may possibly explain why Billings[76] found his series of chronic infectious endocarditis due to a modified pneumococcus, whereas others were commonly finding the streptococcus infection to be responsible for this condition.

Libman[84] has conclusively shown that the *Streptococcus viridans* group is commonly associated with the above type of endocarditis; that hearts showing this type are not uncommon; and that they may become spontaneously bacteria free, and show healing or healed lesions. There are several types of this infection. In one group patients develop a

glomerular nephritis and succumb to uremia. In another group in which there is chronic endocarditis with fever, valve lesions are prominent and there may be petechia of the skin, embolisms, joint symptoms, anemia, with a pale skin, or some degree of pigmentation. In a third group the most prominent features are a diffuse, brown pigmentation of the face, perhaps of the rest of the body, with anemia, usually an enlarged spleen and tenderness of the sternum. The cardiac changes, then, are almost any form of valvular disease, and there may be widespread embolism. Baehr[85] describes lesions of the kidney, embolic in nature and involving the glomeruli especially. As was said, kidney insufficiency was a common cause of death. The blood may become bacteria-free and some patients recover.

CHRONIC INFECTIOUS ENDOCARDITIS.

This is often engrafted on an old valve lesion. The extent of the valve lesion and of the old myocardial involvement may have a bearing on the clinical course of the disease; where both are marked, with the implantation of the new infection there may be early signs of heart failure with congestion. In such a condition the blood culture alone may reveal the infectious nature of the condition. In infectious endocarditis, in those individuals without serious chronic valvular and myocardial disease, the course may be mild and prolonged. The description given by Osler[86] of his ten cases in 1909 embraces the following characteristics: The disease may be long, extending from four to thirteen months, and the patient may be ambulatory and keep at his work, although he shows a daily rise of temperature and occasional sweat. Sometimes fever is the only symptom for a long time. In some cases recurring chills suggest malaria. The fever and sweats may suggest beginning tuberculosis. No changes in the intracardial murmurs may be detected, especially where the mitral valves are affected, but with involvement of the aortic valves, the progress of the disease within the heart may be more evident. Embolism is a late manifestation. Osler states that ephemeral cutaneous nodes, the red raised, painful spots on the skin of the hands or feet, lasting

but a few days, rarely occur except in this form. At post mortem the vegetative endocarditis, involving especially the mitral valves, may be found; sometimes the aortic and tricuspid valves are involved, as well as the walls of the heart, and the chordæ tendineæ. The vegetations found are large and firm. In Billings's series of fourteen cases, eleven were due to the pneumococcus and three to a streptococcus.

Treatment. Endocarditis, like pericarditis, is a condition which emphasizes the necessity of eradicating infective foci in the individual. We can do but little to prevent endocarditis in adults or children, once rheumatism manifests itself. We should remember that in children the manifestations of rheumatism are insidious, so that absolute rest for a prolonged period is even more desirable, if such a thing were possible, than it is in the adult.

In simple acute endocarditis supposed to be of rheumatic origin, the combination of sodium salicylate and sodium bicarbonate, or a similar combination, should be used. We can not say that it will prevent endocarditis in rheumatic fever, but on the other hand there is not sufficient reason for thinking that it depresses the heart if given in reasonable dosage.

An ice bag to the precordium is desirable. Repeated blisters to the precordium have been advised, though the benefit from their use is problematic. Diet should be light and nutritious. The circulation should not be overloaded with liquid. Thirty-two to forty-eight ounces in twenty-four hours should be sufficient. Prolonged, absolute rest in bed is by all odds the most important element in treatment. Especially with young persons, three months is not too long a period for rest and where there is any continuous rapidity of the pulse or any signs of myocardial involvement after three months of recumbency, then another period of three months complete rest, under observation, is not too much if the best results in obviating future trouble are to be obtained.

The treatment of the malignant form of endocarditis is the treatment of septicemia. Theoretically an autogenous vaccine should be good, therefore a blood culture should be taken of these patients so that vaccine may be prepared. However, its use finds but few enthusiastic adherents. Stock antistreptococcus serum has been recommended in the strep-

tococcic form; my experience with it years ago was not satisfactory. We know now that the strains of streptococci are many and that in the stock forms of sera and vaccines the element of specificity is lacking.

In subacute bacterial endocarditis of the streptococcus viridans type, Billings and Raulston[87] have used the cacodylate of soda intravenously and subcutaneously for several years with encouraging success. The treatment should be begun early. They write that ten to fifteen grains may be used daily hypodermically, and ten to fifteen grains every two or three days intravenously. It should be given in sterile normal salt solution. After ten days or two weeks it may be omitted for a week. He has never observed evidence of arsenical intoxication or other unfavorable results of its use. However, it would seem prudent to begin with not more than one-third of the doses recommended and increase them to the maximum amount if frequent examinations of the urine shows no kidney irritation. Munzer has recommended the use of arsphenamin intravenously.

Parsons-Smith[88] thinks that subacute bacterial endocarditis is not the result of one specific organism, as a pneumococcus, gonococcus, influenza bacillus, and other streptococci than the viridans have been found the dominant microorganisms at times. This suggests the use of the arsenic preparation in all these forms of subacute endocarditis. These patients will be few, as Libman finds that fully ninety-five per cent. of patients with subacute endocarditis show the *Streptococcus viridans*.

CHRONIC ENDOCARDITIS.

This form may be primary, but it is more often secondary to acute rheumatic endocarditis. The valve leaflets are especially involved and show thickening, shrinking, and they may be adherent and atheromatous. The chordæ tendineæ also become thick and short. The result is incompetency or narrowing of the opening or both.

The *causes* are: In the first place, an end result in acute endocarditis; again it may be a part of a general arteriosclerosis. The valve cusps, with increasing years, are subject

to the same sclerotic changes and calcification that the vessels undergo. Infections, even remote, hypertension, and especially syphilis, are provocative of these changes. The mitral orifice is affected almost twice as often as the aortic; the tricuspid and the pulmonary valves may also be affected but their involvement is relatively infrequent compared with the former two. Vegetations on the valve are not common in this form of endocarditis, but occasionally the same vegetations found in simple endocarditis are present; also the sclerotic valves may show ulceration. The presence of vegetations or ulceration probably means a recurrent endocarditis fastened upon an old sclerotic valve, which, as we have seen, is not an uncommon occurrence. Chronic mural endocarditis occurs especially as white patches in the ventricle or auricle; they are especially evident in the left ventricle in occlusion of the descending branch of the left coronary artery; similar patches also occur when this artery is tied off in experiment; beneath this patchy chronic endocarditis, the Purkinje system and the myocardium are involved. This leads to definite subendocardial myocardial disease, with the conduction disturbances found in "arborization block."

However, chronic endocarditis, like the acute form, involves especially the lining membrane of the valves, and this leads to chronic valvular disease, which in turn leads to insufficiency or stenosis of the orifices in the heart. The two may exist separately or together. The narrowed orifice prevents a full outflow from a chamber, whereas an incompetent orifice allows the blood to take an abnormal course; in both conditions, the cardiac chambers become over-filled, which leads to a certain degree of dilatation, followed by hypertrophy. The clinical picture depends upon what valves or combinations of valves are affected. This brings us to the subject of chronic valvular disease.

Aortic Insufficiency.

Aortic insufficiency arises from disease of the cusps ordinarily, less frequently because the valves are unable to close an abnormally large orifice. Especially in middle aged patients, syphilis is the commonest cause and frequently in-

volves also the proximal portion of the aorta; this often leads to dilatation of the aortic ring with relative insufficiency. Endocarditis by ulceration and distortion of the valves is another cause; rheumatic fever, though less prone to produce ulceration, causes insufficiency and sometimes narrowing by old vegetations or by sclerosis and adhesions of the valve segments. Arteriosclerosis is a common cause; here the arch of the aorta and the coronary arteries are also often involved. When the ascending portion of the arch of the aorta is greatly dilated, or there is actual aneurism just beyond the aortic ring, relative insufficiency of the aortic orifice is common. Though rare, rupture of a valve cusp due to excessive strain, as in lifting, does occur, especially where the valves are diseased. It is said that in the group due to endocarditis the insufficiency is often accompanied with some stenosis, but such narrowing is less common in the arteriosclerotic group.

The first result of aortic insufficiency is an over-filling of the left ventricle, which leads to dilatation and then hypertrophy as the heart muscle reacts to the demand upon it. In this condition dilatation and hypertrophy reach extreme limits. These so-called bovine hearts are the heaviest on record. As dilatation and hypertrophy increase, relative insufficiency of the mitral orifices arises. Enlargement of the same character takes place in the right side of the heart where aortic incompetency has existed for some time. Patients with aortic incompetence are apt, especially in middle life or a little beyond, to show arteriosclerosis. In many of these the aortic disease is secondary to the sclerotic process, but even in the endocarditic group, the forceful output of blood places the arteries under great strain, and tends to lead to sclerosis in their wall. In the arteriosclerotic group, as has been said, the first part of the aorta is apt to be involved also, so that the coronary arteries are prone to sclerosis and occlusion, which lead to chronic myocarditis.

Symptomatology. The onset of symptoms may be insidious. Dyspnea on exertion, vertigo, headache, syncopal attacks, and sleeplessness are among the early symptoms. Precordial pain is an early feature. It may be localized to the precordium, but it tends to show the character of genuine

angina pectoris with the same areas of radiation. The worst attacks occur in those patients who also have involvement of the aorta. The patient appears anemic, but when relative mitral incompetence arises the face may be dusky or cyanotic. When the myocardium begins to weaken, the signs and symptoms of heart failure with congestion, arise—dyspnea which is especially marked at night, and cough due to congestion or edema of the lungs. Hemoptysis rarely occurs. There may be some edema of the ankles, but no general dropsy unless there is complicating mitral disease. Embolic symptoms are rare, mental symptoms, such as delirium, hallucinations, delusions, and even suicidal tendencies are common. Sudden death occurs more frequently in this form of chronic valvular disease than in any other.

Physical Signs. In early cases or those with slight insufficiency there may be but little cardiac enlargement, but ordinarily a heaving apex beat may be found as low as the sixth or seventh interspace, and more than eleven centimeters from the midsternal line. The area of cardiac dullness is increased, especially downward and to the left. Rarely a diastolic thrill is felt; when present it may be more intense in midsternum or even lower. Bulging or pulsation of the precordium occurs more often in the young. On auscultation a diastolic murmur is heard at the base of the heart, transmitted down the sternum; its point of maximum intensity varies, sometimes being heard better at the aortic cartilage, in early cases along the left border of the sternum; again, immediately over the midsternum; occasionally it may be heard as low as the ensiform cartilage, or even at the level of the apex beat. It is due to the regurgitation of blood into the ventricle, often soft, blowing and prolonged in quality; occasionally it may be rough, and rarely musical. Wilson and Jamieson[89] have recently written on the musical diastolic murmur in aortic insufficiency, and reported cases. These musical murmurs though usually diastolic are occasionally systolic. They are probably produced in one of three ways: By rupture of a valve segment, by perforation of a valve segment, or by a cordlike strand of tissue across the valve orifice. There is often a history of some accident and the valve rupture is supposed to occur in the violent mus-

cular effort made to recover the balance after a blow or fall. It is probable that only diseased valves can be ruptured in this manner. Perforation of a valve giving rise to a musical murmur may be caused under the same circumstances as rupture. It may be the result of ulceration or it may be congenital. The second sound may be heard at the aortic cartilage, it may be obliterated by the murmur, or it may be heard in the carotid artery when absent at the aortic cartilage. When the arch of the aorta is dilated the second sound may be ringing or metallic in quality. The first sound is usually clear at the apex when compensation is good, but beginning with dilatation, the mitral systolic murmur of relative insufficiency appears. There may be a second murmur at the apex, the so-called Flint murmur, or murmur of functional mitral stenosis; it is caused by the current of blood entering the left ventricle from the left auricle, through a mitral orifice, narrowed by the impingement on its anterior leaflet of the regurgitant flow descending from the aortic valve. It may occur in any stage of diastole and may be accompanied by a thrill. It is quite a common finding in aortic regurgitation.

Evident pulsations in the peripheral arteries are common phenomena in aortic incompetence. The carotid, the temporal and the radial are seen to dilate with each heart beat; the same pulsations are revealed in the retinal arteries by the ophthalmoscope. Where the hypertrophy is marked and the anemia decided, this jerking or throbbing of the arteries is particularly evident. Capillary pulsation, as seen beneath the nails after pressure, on the forehead after stroking, or beneath the mucous membrane of the retracted lower lip, is common. Pulsation in the superficial veins, especially on the back of the hand when hanging down, is sometimes seen. The pulse of aortic insufficiency is characteristic; it is called the water hammer, the collapsing, or Corrigan's pulse. Its receding or collapsing quality is best appreciated by raising the patient's arm above his head when palpating the radial. Feil and Gilder[90] have recently studied the pulse of aortic disease graphically. They find the chief abnormal qualities which this form of pulse shows singly or in combination are: An unusually abrupt up stroke; the presence of two

prominent summits of equal or almost equal height (bis-feriens), or of which the first may be of distinctly less amplitude than the second (anacrotic); and the occasional presence of rapid oscillation on the up stroke or plateau constituting a brief thrill. They think that all of these qualities may occasionally, at least, be recognized by the palpating finger; also that the impression of the water hammer quality is caused by the abruptness with which the pulse pressure rises and by this alone. In a typical case the high amplitude, the sudden up stroke and the sudden fall, will be evident to almost anyone at all skilled in palpating the artery. Duroziez's systolic thud or shock, or double murmur, may be heard in the brachial or femoral arteries. Jamieson and Wilson[89] have recently studied the pistol-shot sound in aortic disease. They find that systolic sounds in the femoral artery are not confined to aortic insufficiency, but that these sounds are very frequent and very loud in this condition. They noted that the pistol-shot sound was not confined to the femoral, but was also found in the dorsalis pedis or the posterior tibial artery. By careful graphic study they were able to demonstrate conclusively that the pistol-shot sound is not transmitted from the heart but is produced at the point where it is heard by the impact of the pulse wave, a finding which they expected.

Blood-pressure studies in aortic incompetence afford valuable evidence. The great divergence between systolic and diastolic pressure in the arm is suggestive. Thus the normal average pulse pressure of forty to fifty may be doubled. The marked difference between the systolic pressure in the leg and in the arm in aortic incompetency is striking. The systolic pressure in the leg is much higher than in the arm. In the leg the divergence between systolic and diastolic pressure is more marked, so that the pulse pressure in the leg may be double the high values found in the arm. Williamson,[91] in a recent study of twenty-four cases of undoubted and well marked aortic incompetence, found that in fourteen of these a difference existed between the arm and leg readings. In the other ten cases there was either a higher arm than leg reading, or there was no difference in favor of the leg. Ten of the cases showing the difference

had thick arteries, which he thinks strongly suggest the arterial origin of the phenomenon, especially as he finds it is not a constant sign of aortic regurgitation. He thinks that hypertonic contraction or hypertrophy of the muscular coat of the vessels, with or without sclerotic changes, may be responsible for the difference in pressure. This seems sub- stantiated by the fact that he found this difference in pres- sure between the arm and leg occurred twice as often in adults as in children who had no thickened arteries.

Graphic studies give a characteristic polygram. In the arterial tracing, the ascent is high, the top ordinarily sharp and its drop quick, with a poorly developed dicrotic notch and wave.

Diagnosis. A diastolic murmur at the base, usually in the second interspace to the right of the sternum, often in the second left interspace, transmitted down the borders of the sternum to the apex beat, is a sign of aortic regurgitation. In early cases the murmur is frequently heard to the left. Aortic regurgitation with the Flint murmur at the apex may be difficult to distinguish from organic mitral stenosis. One must consider the collateral signs and symptoms in making a differential diagnosis. In mitral stenosis the apex impulse is a sharp tap with quick withdrawal; in aortic regurgita- tion, a powerful heave with slow recoil; in mitral stenosis, the pulse is small and the pulse pressure is normal or low, whereas in aortic regurgitation, the pulse is Corrigan in type and the pulse pressure is high. In x-ray study of the heart there is the mitral shape as contrasted with the longer di- ameter of aortic regurgitation. In the electrocardiogram, right sided preponderance and a tall and wide P indicate stenosis; left ventricular preponderance, aortic insufficiency. The diastolic murmur of aortic regurgitation is transmitted along the borders of the sternum; it is higher pitched and runs throughout diastole. White emphasizes the fact that in mitral stenosis the murmur commences at a definite in- terval after the second sound. Furthermore, the Flint mur- mur is inconstant; it tends to disappear and reappear. To most observers the Graham Steell murmur has always ap- peared to be uncommon, while others find it quite common. It is a high-pitched, diastolic murmur, heard best at the

third left costal cartilage. It is supposed to be due to functional regurgitation through the pulmonary valve because of increased pressure in the pulmonary artery. Its time, position and quality are those of the murmur of aortic regurgitation. The distinctions rest upon the well-known symptoms and signs of aortic insufficiency. The water hammer pulse, throbbing carotids, capillary pulsation, and the pistol-shot phenomenon in the leg arteries, are characteristic signs, especially where the amount of regurgitant blood is considerable. Evident enlargement of the heart to the left and downward, the high pulse pressure, the electrocardiogram of left sided preponderance, the anemic appearance, the history of rheumatism in young individuals, also the history of syphilis and the presence of a positive Wassermann, are all important points. The course of aortic insufficiency varies. Sudden death is commoner in this valve lesion than in any other. On the other hand, many patients maintain their compensation for years; naturally, these patients are among those whose insufficiency is due to a preceding endocarditis. In the arteriosclerotic group there is a tendency to coronary artery involvement, and the resulting myocardial degeneration. This degeneration, involving first the arch of the aorta and the coronaries, passes to the myocardium with the resultant disturbances of compensation. The impaired arterial circulation first affects the brain, vertigo, fainting, flashes of light, and mental disturbances appearing. With the appearance of mitral insufficiency, engorgement of the lungs and general dropsy occur and may terminate the life of the patient.

Aortic Stenosis.

Narrowing of the aortic orifice is much less common than insufficiency. It is often combined with insufficiency, especially in the endocarditic type. Stenosis is less common in the arteriosclerotic form of aortic insufficiency. With aortic stenosis, however, there is usually some degree of insufficiency, however slight it may be. Adhesion between the valve leaflets, thickening with loss of pliancy, and even calcification, are among the causes. Where the valve leaflets are simply stiffened, they can not be pressed back

against the aortic wall by the blood current; when calcified, they may stand almost rigid and offer only small opening for the blood stream. By "relative aortic stenosis" is meant a condition in which the proximal portion of the aorta is greatly dilated, while the ring and valve remain normal; genuine aortic stenosis is a disease which is associated with atheroma in an advanced stage, especially in men. Stricture of the aortic orifice leads to hypertrophy of the left ventricle with but little or no early dilatation. In this respect it contrasts strongly with aortic incompetence. As Osler and McCrae[5] state, we find in this condition the most typical instances of concentric hypertrophy in which without much, if any, enlargement of the cavity, the walls are greatly thickened. With time, however, dilatation begins—first ventricular, and then auricular—with pulmonary stasis and all the symptoms and signs of failure with congestion.

Diagnosis. A systolic thrill at the level of the second cartilage may be present, is often intense, and is a decisive diagnostic point. A rough systolic murmur, maximal at the aortic cartilage, and transmitted into the neck vessels, may be a sign of aortic stenosis, but more often it is not. This murmur is frequently due to changes in the blood, to roughening of the aortic wall, and to rigidity of the valves without stenosis. Lewis's[92] advice that to diagnose aortic stenosis, it is necessary first to diagnose regurgitation, is particularly applicable before middle life. A diastolic murmur is common in this condition, and the combination of systolic and diastolic murmur at the aortic cartilage, in an old arteriosclerotic subject, may well be associated with aortic stenosis. The pulse in aortic stenosis is regular, anacrotic, or flat topped, and often slower than normal.

The cardiac impulse and cardiac dullness are not always in proportion to the amount of hypertrophy, as these patients are prone to have emphysematous lungs; in some cases, the heaving impulse may be present; pain, especially anginal in character, is not so common in these cases as in aortic insufficiency. With beginning myocardial failure, the same cerebral symptoms are present as in insufficiency. With progressive myocardial failure, the relative mitral insufficiency appears and in its wake cardiac failure with congestion.

Mitral Insufficiency.

Insufficiency of the mitral orifice arises from contraction and distortion of the valves and coincident shortening of the chordæ tendineæ. It is often combined with some stenosis of the mitral opening. It also arises in dilatation and hypertrophy of the ventricular muscles, which increase the mitral opening to such a degree that the mitral valves are no longer able to close it. Endocarditis is a common cause and it is in this form that regurgitation and obstruction may be combined. As intimated, relative mitral insufficiency occurs in left ventricular dilatation and hypertrophy; it also may occur when the ventricular muscle is weakened by prolonged fevers and anemic states. The results of mitral insufficiency upon the heart itself are, dilatation, followed by hypertrophy in the left auricle, the left ventricle, the right ventricle, and finally the right auricle. As long as hypertrophy keeps pace with valve defects, all will be well, but with failure of this compensation, the lungs are early engorged, which increases the work of the right heart.

Relative mitral insufficiency, arising either from a weakened muscle, in acute diseases, or following in the wake of dilatation and hypertrophy in arteriosclerosis, in hypertension, both renal and essential, may be quite as evident, though there is no real valve lesion.

Symptomatology. Even when compensation is good, the patients with marked mitral insufficiency may note some shortness of breath on exertion; there may also be slight congestion of the lips, and in old cases, clubbing of the fingers. The pulmonary circulation is never perfect, so that these subjects are prone to bronchitis. Aside from this, many people with this lesion go through life with no further symptoms. With failing compensation, which may be precipitated by some acute illness, venous stasis, pulse irregularity which is often due to auricular fibrillation, engorged pulmonary vessels—giving rise to dyspnea and cough, and sometimes blood-stained expectoration—cyanosis and slight jaundice, all are common symptoms. Edema, beginning in the feet, may become general, and also involve the serous cavities. Right-sided hydrothorax is commoner than left-sided, as

Stengel[93] and Steele[94] pointed out. The most satisfactory theory to explain the preference of pleural effusions for the right side supposes that an enlarged right heart, and especially the right auricle, press on the root of the right lung and obstruct the vena azygos major. With rest and treatment, especially in those patients with auricular fibrillation who react well to the digitalis series, all these symptoms may disappear. Sudden death with these patients is rare. More often recurrent attacks with general dropsy end the history.

Physical Signs. The apex beat occasionally is in the sixth interspace and to the left, but hypertrophy in mitral lesions is never so marked as in aortic lesions. The cardiac dullness is increased transversely and especially to the right. Clear dullness to the right of the right sternal border is due to right auricular enlargement, which is accompanied by a definite over-distension of the veins of the neck, especially in the recumbent position. The teleröntgenogram shows the characteristic mitral shadow. It is characterized by its broad transverse diameter. Occasionally a marked impulse of the epigastrium may be shown by a polygram to be due to the right ventricle. At the apex a systolic murmur is heard; it may be of any character, from blowing to musical; its line of transmission is from the apex to the axilla and to the back. The systolic murmur may wipe out the first sound. The second sound may be heard at the apex. A presystolic murmur may also be present and the pulmonary second is usually accentuated. As long as the pulse remains regular, there is little characteristic of the disease about it. When irregularity occurs, it may be due to extra systoles, but very often to auricular fibrillation.

Diagnosis. Formerly mitral incompetence was considered one of the easiest lesions to diagnose, but increasing experience has shown that it is more difficult than was supposed. It was said without reservation that a systolic murmur with maximum intensity at the apex, transmitted to the axilla and heard at the angle of the left scapula, meant mitral insufficiency. This is far from true. Lewis states that almost any type of apical systolic murmur may be heard—soft, blowing, harsh or musical—and yet at autopsy no fault may be found with the mitral valve or ring. Again, the valve may be de-

fective or the ring wider than normal and there may be no murmur. Moreover, there is no sure way of differentiating between insufficiency due to mitral valve lesions and mitral ring dilatation. Even the presence or absence of hypertrophy is less important in some cases than the medical history. Some writers maintain that organic disease of the mitral valves sufficient to allow regurgitation is always accompanied with a certain amount of stenosis, so that the only absolute proof of actual disease in the mitral valves is the presence of a presystolic murmur. But even in some cases of actual mitral stenosis the systolic murmur is variable in its qualities, its presence and its conduction. Mitral systolic murmurs which are constant from day to day suggest an organic basis. This is more likely if the patients have a history of genuine rheumatic fever. The cardio-respiratory systolic murmur, heard best at the apex, sometimes extending even to the angle of the left scapula, may be quite as evident as the murmur of genuine mitral regurgitation. However, this murmur is better heard during the inspiratory period of respiration. It is looked upon as a breath sound accompanying a cardiac systole. Again, a systolic murmur at the apex suggesting mitral disease indicates the use of exercises to test cardiac competence. In genuine mitral disease electrocardiograms show some auricular hypertrophy and right ventricular preponderance; their presence is confirmatory but their absence means little, as the amount of hypertrophy of the heart in mitral disease is small when compared in terms of aortic disease. Thus the apex beat may be downward and to the left or it may not; a heart dullness fairly wide and transverse in diameter, or a teleröntgenogram showing the wide mitral shadow, are helpful points in diagnosis. Distinct accentuation of the second sound is a constant symptom.

Mitral Stenosis.

Narrowing of the mitral orifice leading to stenosis is an important valve lesion, especially as in mitral stenosis, just as in aortic disease, the morbid process is not confined to the valves and endocardium but extends to the myocardium as well. This involvement of the cardiac muscu-

lature is revealed by the fact that almost half of the hearts developing auricular fibrillation, especially before middle life, show mitral stenosis. It is much commoner in women than in men. Rheumatism and chorea are more common in girls, so that mitral stenosis is a common finding in young women. Most often there is a history of antecedent acute endocarditis, the valve segments may be adherent, the chordæ tendineæ thickened and contracted, and there may be much calcification, all leading to varying grades of constriction, down to almost total obliteration of the mitral orifice. Often in mitral stenosis the heart is not much enlarged, and the left ventricle is small in comparison to the right. Thrombus formation in the auricle is very common, which leads to the embolic features later to be described. The result of interference with the normal blood flow, due to the narrowing of the mitral opening, leads first of all to left auricular dilatation and hypertrophy. The damming back of blood in the pulmonary circulation leads to right ventricular hypertrophy with relative incompetency of the tricuspid valves, and overfilling of the systemic veins, a condition suggested by prominent cervical veins, especially in the recumbent position.

The cause in most cases is a previous endocarditis. There is often an antecedent history of acute rheumatic fever, chorea, growing pains in childhood, repeated tonsillitis, sometimes puerperal sepsis, scarlet fever, or other pyogenic infections. A history of their previous presence is a distinct aid in diagnosis, but there are patients who show hardening, distortion and constriction of the valves of unknown cause. The symptomatology in this affection depends upon heart failure with congestion when it is marked, but with slight cardiac weakness there may be precordial distress, dyspnea, and cough on exertion; however, these are not characteristic of the complaint, as they may occur in any form of cardiac disease. The stasis in the auricles with both regular and irregular rhythms leads to comparatively frequent thrombosis, hence the rather common embolism in this disease. When the left auricle is involved, embolism of the systemic circulation, especially brain, kidney, and spleen, arises. When the embolus comes from the right auricle, it commonly lodges in the lung. Mitral stenosis is the lesion most commonly

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associated with hemoptysis. Goodman[95] has stressed the impairment of resonance of the apex of the left lung in this form of valvular disease. This impairment, especially if associated with hemoptysis, suggests pulmonary tuberculosis, whereas pressure due to the left auricle is probably the cause of the dullness. That the two conditions may coexist was illustrated recently in a colored man, of about thirty, in the medical wards of the Presbyterian Hospital. He had a well-developed mitral stenosis, some dampening of percussion resonance in the left upper lobe, and a sputum containing blood and abundant tubercle bacilli. Examination revealed the fact that the more marked infiltration and softening was in the right upper lobe. Aphonia is not uncommon in these cases, due to pressure by the enlarged left auricle on the left recurrent laryngeal nerve. This leads to paralysis of the vocal cords on the corresponding side, which naturally suggests pressure from aneurism. Norris and Fetterolf[96] believe that it is not direct left auricular pressure but pressure upon the nerve caught between the pulmonary artery and the aortic arch, which leads to neuritis and paralysis. In long-standing cases there may be some clubbing of the fingers, and slight flushing and cyanosis of the cheeks and lips, with a background slightly icteroid. The patient is often poorly developed and under nourished, his face drawn and his extremities cold. A visible apex impulse is oftener than not in its normal position in the fifth interspace. Occasionally in hearts showing considerable hypertrophy, it may extend almost to the anterior axillary line, but the occasional patient showing the systolic apical retraction in the sixth or even the seventh interspace, well out toward the axilla, is rare. In these patients the right ventricular hypertrophy is most marked. Commonly, palpation finds the apex impulse in the fifth interspace, near the left midclavicular line. With much enlargement it may be farther out and occasionally downward. This impulse is usually a sharp quick stroke, practically never heaving and prolonged. A thrill may be present or absent; when present it may be systolic, diastolic, or both. It is of diagnostic value only if it is clearly diastolic in time and is a genuine purr. The pulse in mitral stenosis is not characteristic. The pulse pressure is moderate

and the average blood-pressure in Goodman's twenty-four cases was, systolic 132, and diastolic 78. Absolute arrhythmia is common and due to auricular fibrillation. Percussion will show a wide area of dullness, laterally, if the heart is enlarged. The x-ray shows the "mitral shape," which is broad and rounded. The prominence of the left auricle and also of the right, especially with auricular fibrillation, are important elements in determining the shape of the x-ray silhouette. Increased dullness from the second to the fifth interspaces, with the convexity toward the left axilla, means a much enlarged left auricle and suggests mitral involvement. The increased dullness to the right of midsternum means an enlarged right auricle. It is not confined to mitral stenosis.

If auscultation reveals a diastolic murmur at the apex we have sound evidence of organic heart disease, sometimes of aortic regurgitation, often of mitral stenosis. The murmur of the latter condition is apt to be variable and inconstant. When constant, it means that the condition is well established and has existed for some time. The murmur of mitral stenosis is diastolic in time and may occur in early diastole, in middiastole, or in late diastole (presystolic). Again the murmur may occupy the entire diastolic period. Few workers in heart disease today think that the characteristic murmur of mitral stenosis is presystolic. White and Reid[97] emphasize the fact that the diastolic murmur of mitral stenosis does not begin at once with the second sound of the heart but only after a brief but clearly distinguishable pause. The explanation is that the second sound of the heart is produced by the aortic and pulmonary valves, while the mitral and tricuspid valves open at a brief interval later. With the opening of the mitral valve and the dilatation of the ventricle, the blood current from left auricle to left ventricle begins and the murmur arises. For in mitral stenosis the valve leaflets are usually adherent and the murmur is due to the vibration of the valves and the chordæ tendineæ. The intensity of this murmur depends upon the velocity of the flow from auricle to ventricle, although the amount of constriction and the position of the affected valves are factors. The variation in left intra-auricular pressure is the dominant feature in determining the place of the murmur in diastole

and its character. In quality these murmurs are from soft
to harsh, they are referred to as blowing or rumbling, and
they are low pitched. If the murmur fills the whole of
diastole, it may be loud early, grow softer in middiastole and
become more intense in presystole. The middiastolic phase
is diminuendo and is followed by a well marked presystolic
crescendo. Where the murmur occurs definitely late in dias-
tole, especially in well established stenosis, it is apt to be
constant, harsh and terminate in the loud, snapping first
sound. This is the characteristic presystolic crescendo mur-
mur so commonly described. These variations in the quality
of the murmur are best heard in old cases with regular slow
rhythm. The low intra-auricular pressure, as compared with
ventricular pressure, is a possible explanation of the low
pitch and frequent absence of murmurs in mitral stenosis.
The presystolic murmur may be absent where earlier mur-
murs are present and the pulse is regular. Again, with the
onset of auricular fibrillation, the presystolic murmur dis-
appears and the early diastolic murmur persists. Even in
well marked cases of stenosis the diastolic murmur may not
be heard on first examination, especially with the patient in
upright position. In patients with a history of acute rheu-
matic fever or other similar infections, especially if they
have a mitral systolic murmur masking the first sound, a
careful search should be made for mitral stenosis. Its mur-
mur is heard best with the patient lying on the left side,
especially after exercise. Hopping twenty-five times on one
foot and then twenty-five times on the other foot will often
bring out the murmur, especially if the patient at once lies
down on the left side. If this fails in a suspected case, more
strenuous exercises, such as hopping fifty times on each foot
or lifting dumbells, may bring out the murmur in the left
lateral position. The exercise increases the velocity of the
blood current through the stenosed valve and this increases
the audibility of the murmur. A few whiffs of amyl nitrite
will have the same effect. It seems unnecessary to add that
strenuous exercise is not desirable where there are symp-
toms or signs of cardiac failure, though it is in some of these
patients that the murmur of mitral stenosis is absent because
of the low velocity of the blood flow from auricle to ven-

tricle. This low pitched rumble of mitral stenosis is best heard at the actual apex or just to the inner side of the apex. White finds that these low pitched murmurs are heard best with the plain bell attachment of the stethoscope, whereas he prefers the diaphragm form for the aortic regurgitant murmur. In mitral stenosis the first sound is usually described as sharp and snappy and sometimes it shows a duplication. The second sounds, especially the pulmonary, are accentuated and they may be doubled. This serves to suggest, especially in the presence of a history of acute rheumatic fever, the desirability of seeking out the murmur of mitral stenosis. The electrocardiogram may show auricular hypertrophy, that is, a P wave over three millimeters in height and over one-tenth of one second in width. Also there may be evidence of right ventricular preponderance. If these changes are present in the electrocardiogram we may be reasonably sure of mitral stenosis, but their absence proves nothing. Naturally in auricular fibrillation there is no P wave.

Mitral stenosis may be confused with aortic insufficiency where the Flint murmur is present. The differential diagnosis was discussed under the heading of aortic insufficiency. There are some patients in whom there appear to be the combined lesions of aortic insufficiency and mitral stenosis. In these cases it may be impossible to differentiate the genuine mitral stenosis complicating aortic regurgitation from the latter accompanied by a Flint murmur, the so-called functional mitral stenosis. In heart disease of rheumatic origin both aortic and mitral valves may be involved, while in syphilis aortic involvement alone is commoner. The functional pulmonary regurgitant murmur, the so-called Graham Steell murmur, was also referred to in discussing aortic incompetence. Sewall[98] has pointed out how the overacting normal heart may occasionally simulate mitral stenosis, and the same is true of the irritable heart and occasionally in hyperthyroidism. In the latter the increased metabolic rate, the enlarged gland and other symptoms serve to differentiate the two conditions. In the irritable heart the confusion need not arise unless the examination is confined to the heart alone; sometimes the irritable heart and mitral stenosis co-

exist. Confusion in diagnosis usually arises from paying too much attention to the presystolic element in the heart murmur. Finally, the diagnosis of mitral stenosis rests upon: an antecedent history of acute rheumatic fever; a loud, snapping, first sound at the mitral area; a diastolic murmur often with a presystolic phase; the "mitral ·shape" of the x-ray shadow, and lateral enlargement by percussion; sometimes the peculiar facies; the history of embolism; and the presence of auricular hypertrophy and right ventricular preponderance in the electrocardiographic curves.

Tricuspid Incompetence.

It is usually a relative incompetence, especially secondary to mitral disease. Sometimes it follows endocarditis. It is found in obstruction of the pulmonary circulation as in fibroid phthisis and emphysema. The condition may cause marked systolic pulsation of the cervical veins, also sometimes of the inferior vena cava and liver. Where the incompetence is marked the polygram from the jugular shows the ventricular form of venous pulse and the tracing from the liver reveals a systolic pulsation. The dilated auricle is at a standstill though the cardiac rhythm be regular. A systolic murmur with maximum intensity over the lower part of the sternum or ensiform cartilage is usually said to be due to tricuspid regurgitation, but since it is well recognized that such a murmur may be induced in healthy people after strenuous exercise, the murmur alone is not satisfactory evidence of tricuspid disease. A constant systolic murmur in this region associated with enlargement of the heart to the right is a more important sign.

Tricuspid Stenosis.

This lesion is very infrequent, rarely diagnosed clinically, usually being recognized only at post mortem. It is marked by extreme dyspnea and cyanosis, and there may be extreme hypertrophy of the right auricle, leading to presystolic pulsation in the veins and in the liver. Mackenzie was able to detect the presystolic tricuspid murmur over the middle of the sternum. As in the majority of cases the mitral and

tricuspid valve are affected at the same time, there may be the diastolic murmur of mitral stenosis at the apex.

Pulmonary Insufficiency.

This lesion is rare. It may arise in infectious endocarditis, but the Graham Steell murmur is diastolic in time and is heard at the pulmonary cartilage. It is said to be due to a functional regurgitation through the pulmonary valves because of increased pressure in the pulmonary artery. In time, position and quality, it simulates the murmur of aortic incompetence. The differentiation is founded upon the other well-known signs of aortic insufficiency.

Pulmonary Stenosis.

Pulmonary stenosis is almost without exception a congenital lesion. It occasionally occurs in adults. In congenital cases the narrowing of the pulmonary orifice is often associated with an open ductus arteriosus and sometimes a patent ventricular septum. It is an important lesion in the young and the frequency with which a systolic murmur occurs at the pulmonary cartilage in adults concerns us in considering the diseases of middle life, for though actual lesions of the pulmonary valves are comparatively rare, systolic murmurs at the pulmonary cartilages are very common. It is a favorite site of the cardio-respiratory murmur; it is found in anemia, also in overacting hearts in health. In the recumbent position, especially on expiration, it is found when the heart is normal. This murmur may be soft or harsh and it may be heard from the second to the fourth left costal cartilages, but pulmonary stenosis should never be diagnosed on the murmur alone. Where there is a genuine lesion, the murmur is well transmitted in the line of the left clavicle, also there should be a well-developed thrill in the region of the pulmonary cartilage and constant or transient cyanosis of the lips. The electrocardiogram should show well developed right-sided ventricular preponderance; the systolic murmur of mitral insufficiency and the murmur of aortic stenosis may suggest it. The pulmonary second sound may be absent or replaced by a diastolic murmur. Pulmonary

stenosis is often associated with patency of the ductus arteriosus, which gives rise to an unbroken murmur, running throughout systole and well into diastole.

Prognosis in Valvular Disease. The outcome depends largely upon the myocardium, for especially in mitral stenosis and aortic disease the pathologic changes are not limited to the valves, but involve the myocardium as well. This may also be true of other valve lesions, whether the causative factor may be rheumatic fever or syphilis. The amount of myocardial involvement is usually greater in aortic disease due to syphilis than to rheumatic fever, because syphilis tends also to affect the proximal portion of the aorta and the coronary vessels. The development of auricular fibrillation, auricular flutter, heart block or alternation, points to myocardial disease. Persistent high blood-pressure, whether renal or of the essential type, leads to an overtaxed myocardium. A definitely enlarged heart points to an unsound myocardium. The outcome of myocardial involvement is finally heart failure with congestion, sometimes heart failure with angina pectoris alone, because both coronary arteries and heart muscle are involved. In aortic insufficiency sudden death is not uncommon. It arises either from obstruction of a coronary artery or from acute dilatation following some exertion. This lesion is also frequently associated with angina pectoris which adds to its gravity. Aortic valve disease due to rheumatic fever has a better outlook because the aorta and coronary arteries are less often affected. The reverse is true in aortic disease due to syphilis and arteriosclerosis. Aortic stenosis develops late in life, especially in elderly men. In mitral stenosis the outlook is, on the whole, better than in aortic disease. Embolism is one of the chief dangers. Some patients with no signs of myocardial failure may lead their ordinary lives for years. This is particularly true of women whose activities are, on the whole, less strenuous than those of men. Mitral insufficiency ordinarily presents a better prognosis than mitral stenosis. Well compensated cases may go on for years with no inconvenience. The future in any valve lesion depends upon well balanced compensation; so long as this persists there may be comparatively little disturbance in circulation. The amount of myo-

cardial involvement is always more important than the valve lesion.

Treatment. As long as the valve lesion is balanced by sufficient hypertrophy no medication is needed. In aortic lesions patients should be warned against sudden over-exertion. A daily warm or tepid bath is desirable, but occasionally patients with aortic incompetence are found frequenting the Turkish bath, which is a bad practice. These patients, especially if they have anginal symptoms, stand sweating badly even by the electric cabinet, however desirable elimination may appear from a renal standpoint.

Patients with valvular disease should avoid very high altitudes. In going to and from the west coast, it is wise for them to keep to their berths in the sleeper while traversing the highest points. If they are prone to seasickness the stress of hard and repeated vomiting is not without danger. Naturally the larger ships are steadier. The common desire to make airplane flights suggests the necessity of including that among the restrictions. Recently a woman with well developed aortic incompetence, with some anginal symptoms and some cardiac distress on any unusual exertion, contrary to advice, made a flight fortunately without any ill results.

Patients should be advised to lead as quiet lives as possible, free from excitement, worry and over-exertion. Plain food in restricted amounts is highly desirable. Over-indulgence in tobacco is harmful and much alcohol is certainly undesirable. The tendency of recurrent endocarditis to attack an old diseased valve makes it important that all possible foci of infection should receive attention. Where the patient has no cardiac symptoms quiet exercise is beneficial; walking and even golf are helpful if carried only to a point where they produce no symptoms, the feelings of the patients being the best guide. Any amount of exercise which produces any dyspnea or heart consciousness should be restricted. Beginning cardiac failure most often is heralded by marked shortness of breath on exertion. In aortic incompetence and incipient anginal failure, this dyspnea is associated with pain. The appearance of irregularity of the heart's action calls for an accurate diagnosis and for treatment as recommended in considering the various forms of

cardiac arrhythmia. More serious cardiac failure is shown by cyanosis, rapidity of the pulse, possibly arrhythmia, dilatation and various degrees of edema. These all point to weakening of the myocardium. They call for rest and the digitalis series. This subject will be further considered in the chapter on the general treatment of cardiac disease.

THE SYMPTOMATOLOGY OF CHRONIC HEART DISEASE.

Freedom from symptoms in chronic heart disease means an efficient myocardium; more often this is due to compensatory hypertrophy rather than an unaffected muscle, especially in such conditions as well established valvular disease. Among the first symptoms of a failing myocardium is shortness of breath, especially on exertion. The patient becomes conscious of the fact that ordinary exercise, as stair climbing and other activities of the day, cause breathlessness. Later, with a marked loss of cardiac reserve the patient may be breathless even at rest. Other causes of breathlessness must be eliminated. It occurs in anemia, in renal disease, in a convalescence after acute disease, especially on exertion, in obesity, in tuberculosis, and there is a nervous type which occurs in the so-called neurasthenics and in those with the definite complex of the effort syndrome. Breathlessness may be a sign of acidosis, as in kidney disease; the latter may be associated with cardiac disease but it is the renal insufficiency that is the larger factor. In pure cardiac cases with some failure of reserve there may be a slight amount of acidosis. As has been pointed out, especially by Lewis,[99] a differential point in dyspnea due to renal disease is its persistence at rest and at night, whereas dyspnea which occurs during the day only is more often nervous in type; it may be due to the effort syndrome, or it may be hysterical.

A few years ago, I took tracings on several occasions of a woman in the third decade whose constant respiratory rate at the time I saw her was sixty per minute. Dr. Herbert B. Carpenter, her physician, informs me that he frequently found the rate as high as eighty per minute, and that the high rates of from sixty to eighty persisted at least four

years. In addition to the nervous element, she had a rather marked peri-bronchial gland infiltration, and had some old pleural adhesions, possibly tuberculous in nature. There was no evidence of any active tuberculous process, and Dr. Carpenter tells me that she has improved immensely since living in southern California.

Difficulty in breathing is a clinical sign that the reserve power of the heart muscle is lessened. It is commonly accompanied by some degree of cyanosis in heart disease. The respirations may be rapid and shallow, occasionally they are slow and deeper than normal. The causes of dyspnea in heart disease are probably multiple. Peabody[100] and his associates have shown that in severe cardiac disease an increase in the minute-volume of air breathed while the patient is at rest is common. At rest a normal man breathes about four hundred cubic centimeters per respiration, at a rate of fifteen per minute; thus, the minute-volume of his respiration is six liters. On the other hand, if his metabolism is raised by hard exercise it is possible for him to breathe two thousand cubic centimeters at each respiration, and to increase his respiratory rate to thirty per minute. Thus, the minute-volume of respiration would be sixty liters, or ten times what it was at rest. Pulmonary reserve is the difference between the minute-volume of air breathed at rest and the highest minute-volume which it is possible for an individual to breathe. In cardiac disease with beginning myocardial failure this pulmonary reserve is always much diminished, so that there can not be a normal response to the increased needs due to exertion. This is one cause of dyspnea. Another factor is the occurrence of acidosis. This factor is not large in cardiac disease unless there is distinct kidney involvement as well. Difficulty in breathing or dyspnea in cardiac disease may be of several types: Orthopnea is characteristic of heart disease, and indicates marked exhaustion of the myocardium; polypnea is increased frequency in respiration, the greater the rate in cardiac disease, the greater the severity of the complaint; hyperpnea is characterized by very slow deep respirations. The last is commoner in acidosis. In heart disease it occurs where there is renal insufficiency. It is the type that occurs in diabetic coma. The

Cheyne-Stokes respiration is comparatively common in patients with grave myocardial disease, perhaps more often where there is nocturnal shortness of breath. The estimation of the vital capacity of the lungs affords a clinical method of estimating the pulmonary ventilation. There is a certain parallelism between the amount to which the vital capacity of the lungs is decreased and the severity of the case. It is discussed under the heading of prognosis.

Pain. Next to dyspnea comes *pain* as a signal of cardiac distress; its degree varies in individuals, partly because of their reaction to uncomfortable stimuli and partly because of the degree of structural change producing it. We know little about the actual causes of pain in cardiac disease, except that it means some defect of structure and function of the heart muscle. In degree it varies from substernal distress to the sudden agonizing attack known as angina pectoris. Its association with exertion, its point of origin, and its radiation, are important points in assessing its gravity. Cardiac pain is commonly referred to the superficial precordium. This is common also in functional nervous diseases, and as a reflex symptom in disturbance of the abdominal or pelvic organs. When it arises in the substernal region and has a radiation, especially to the left arm, the left back, and the left neck, it is apt to be of graver import. It is more often left sided; if it occurs on the right side, it is commonly bilateral; it is commonest in syphilitic aortitis, and in aortic valve disease.

The explanation of this connection lies in the common involvement of the mouths of the coronary arteries or the vessels themselves, which leads to impairment in the nutrition of the myocardium. Precordial pain also occurs in the hypertension cases and in aneurism whether due to the diffuse dilatation or sacculation of the proximal aorta. It may occur in paroxysmal tachycardia and in auricular flutter. As stated elsewhere, in one case of paroxysmal tachycardia the pain was so marked that for a long time the patient was supposed to have angina alone. It was only when the patient was seen in the attack that its true nature was recognized. The pain was so great that the rapid heart action made no impression upon the patient. Pain of this character is rare

in auricular fibrillation, but I have recently seen one well developed case. In all these conditions the heart muscle appears to become exhausted, some dilatation ensues and pain follows. Levy[101] has called attention to thrombosis of the coronary arteries as an infrequent cause of cardiac pain; there may or may not be resulting infarction of the heart muscle. Coronary thrombosis may be associated with nausea and vomiting and epigastric distress. It may be severe enough to simulate perforation of a gastric or duo-denal ulcer or acute pancreatitis. There are signs of shock and collapse. These patients, more often elderly men, may or may not exhibit arteriosclerosis with cardiac defects. If infarction follows upon thrombosis of the myocardium, fever and leucocytosis may be found and possibly a pericardial friction. Libman[102] points out that with total occlusion of the right branch rapid and painful swelling of the liver may result, due to failure of the right heart which is largely sup-plied by the right branch. These patients more often suc-cumb early; on the other hand, they may live for some time.

The severest form of cardiac pain is known as angina pectoris; it occurs in middle-aged or elderly subjects; the coronary arteries and the heart muscles are usually diseased, and often there is enlargement of the heart in these subjects, but on the other hand it may be inconspicuous. In genuine angina pectoris, the attacks of pain are paroxysmal and in-tense, the patient feels as if the heart were in a vise-like grip and death impended; the attacks ordinarily appear after exercise and disappear at rest; the genuine form usually starts in the substernal region, radiates to the left shoulder and down the left arm; it is sometimes more intense in the left elbow and fingers; again it may be felt at the left side of the neck, left scapula, left jaw and teeth, and even the left leg. It may be felt in the same regions on the right side; sometimes the pain may be entirely abdominal; pulsus alternans is a common finding in these patients; the blood-pressure may be very high during the attacks; the paroxysm may last from several seconds to several minutes; the epi-gastric distress and the belching afterward suggest to the patient gastric disturbance; after the attack the patient is much exhausted and may pass a large quantity of pale urine;

early attacks may be fatal; on the other hand, they may recur at irregular intervals; often the patients succumb, not in an attack but by heart failure with congestion. Many of these patients are the subjects of advanced myocardial disease which is sometimes associated with disease of the coronary arteries. On the other hand, their structural disease may be hard to demonstrate. Precordial distress in young individuals with nervous temperament, often women, sometimes men, simulates this grave form of cardiac pain; some points of differentiation are that there is no structural disease to be suspected in these cases, that they are younger, that their pain is not precipitated by effort, and that it centers in the precordium rather than in the substernum. The difficulties of differential diagnosis, especially in atypical cases, are illustrated in the history of a woman of about eighty, who came with a history of angina pectoris recurring in paroxysms for over five years. Though the attacks were not typical, the diagnosis seemed reasonable. Following an attack of precordial pain, the patient developed jaundice which in time cleared up, the supposition being that she had passed a gall-stone. A year or two later, one night she developed another paroxysm of pain which was followed immediately by marked acute pulmonary edema, and she succumbed in less than twenty-four hours. Apparently, there were more factors than one in her attacks.

Hyperalgesia of the skin and muscles is common in the area in which pain radiates. This includes the precordia, the left shoulder, the neck, sometimes the jaw and the left arm.

Edema usually occurs about the ankles in ambulatory patients; occasionally it is an early symptom, but more often breathlessness precedes it; the well developed condition with sodden and indurated subcutaneous tissues is well known; it is now recognized that patients may retain an undesirable amount of fluid without external evidence; it is detected by estimating the fluid intake and output and also by weighing the patient daily; the sluggish blood-flow through the kidneys as well as altered composition of the blood lead to perverted kidney function, one result of which is the failure to excrete water. This leads to its accumulation in the dependent portion of the body; in a recumbent patient, in the

back, the buttocks and legs; then follow effusions into the pleural, peritoneal and pericardial cavities.

Cardiac asthma is really a form of paroxysmal dyspnea. The subject, usually elderly, awakes suddenly in the early morning with distress and dyspnea. He may have to sit up or even seek the open window to breathe. Dry râles are evident in the chest, simulating ordinary bronchial asthma. Cough begins, perhaps dry at first, then he may expectorate mucus and if the attacks last long there may be free expectoration of thin, frothy fluid, sometimes tinged with blood. These patients usually do not suffer much from dyspnea preceding the attacks and the day following an attack they are comfortable, but these attacks tend to recur and are often precursors of acute pulmonary edema. Clinically, the two conditions are closely related and, as Pratt[103] writes, "Cardiac asthma is probably an acute passive congestion of the lungs; if an exudation from the congested blood-vessels occurs, the affection becomes edema of the lungs." The only difference is that in acute pulmonary edema there is early evidence of copious moist râles and profuse expectoration of thin, frothy fluid, tinged with blood, which often wells from the nose and mouth. Recurrent attacks of cardiac asthma tend toward acute pulmonary edema. Though they are serious, they may occur under accustomed effort in cases with considerable cardiac reserve. This is illustrated in a patient who, at the age of sixty-six, one evening dressed and ate a full dinner hurriedly, and then started to walk rapidly, on a cold night, to keep an appointment a few squares away. He was seized with cardiac asthma of such intensity that he was carried into a friend's house nearby and had to stay in bed for two days. He was the subject of moderate arteriosclerosis with some "tingling" in the right shoulder, thumb and index finger, but with none on the left side. A little over a year later, on hurrying to keep an appointment on a cold night, he was seized with a severe typical attack of acute pulmonary edema from which he recovered with difficulty. This second attack taught him the much needed lesson, that he must not hurry, especially facing a cold wind. With this restriction he never had other attacks, but succumbed three years later to carcinoma of the stomach and liver.

Palpitation. Consciousness of the heart's action is a common symptom. Frequently due to premature beats, the patient is conscious of the beat of large amplitude following the long pause. The marked thrust of the enlarged heart due to aortic incompetence and hypertension is often felt by the patient. In auricular fibrillation the subject may be unconscious of the irregular heart beat unless the rate be high. Sometimes they are conscious of tachycardia, and the onset and offset of paroxysmal tachycardia are recognized by all sufferers.

Hemoptysis is fairly common in mitral stenosis; it is caused by pulmonary stasis and is often confused with that due to pulmonary tuberculosis; early in the disease the hemorrhages may be small but in later stages they may be copious. There is some truth in the old statement that tuberculosis is not common in mitral stenosis. As mentioned before, we have recently seen a well developed case of mitral stenosis associated with pulmonary tuberculosis and a positive sputum. In *infarction* of the lung, the sputum is bright red, frothy, and does not contain the brown, pigmented, alveolar epithelial cells found in ordinary hemoptysis. An infarct may show definite signs, including a pleuritic friction rub. *Epistaxis* is not common but it has been recorded in mitral stenosis and congenital lesions, especially pulmonary incompetence. *Venous thrombosis* occurs in chronic heart failure; it is commoner in the upper extremity, though any vein may be involved. It is a possible cause of one-sided edema; in general edema, venous thrombosis may be overlooked. It is commoner in severe valvular disease. *Arterial thrombosis* is comparatively rare; it is commoner in the legs and usually results in gangrene. In the skin, we find evidence of *cyanosis,* which is especially marked in the lips, cheeks, nose, ears, finger tips and even toes; it is very common in some degree in congenital lesions; the mitral facies seen in advanced cases is characterized by a flush or cyanosis of the cheeks, with an icteroid background. In aortic disease the face is pale. *Petechiæ* are minute hemorrhages due to bacterial emboli; they occur especially in the conjunctivæ, the mucous membrane of the mouth and the skin of the upper arms and chest. They are frequently associated with infectious endocarditis.

more often when due to streptococcus viridans. *Erythem-*
atous, cutaneous nodes are a sign of chronic infectious endo-
carditis. They are ephemeral, red, elevated, painful, and from
a pinhead to a centimeter in diameter. Their center is white;
their favorite site is the hands and feet; they have a special
predilection for the fleshy ends of the fingers and toes, the
sides of the fingers, the thenar and hypothenar areas, and
the lower forearm. *Cough* is a common symptom; this is to
be expected, as is a certain amount of passive pulmonary
congestion, even early, and a few moist râles at the bases
of the lungs are common findings. *Hoarseness* due to pres-
sure upon the left recurrent laryngeal nerve occurs, especially
in mitral stenosis. *Digestive disturbances* are comparatively
common, as sluggish circulation of the abdominal organs
naturally leads to impaired function; loss of appetite, dis-
turbed digestion and flatulence may occur early, whereas
nausea, vomiting and marked epigastric distress sometimes
due to a passively congested liver, occur later; with marked
failure and tricuspid incompetence the liver is swollen and
tender and may pulsate; at this stage jaundice may be evi-
dent. It is noteworthy how often one sees splenic infarction
at post mortem and how infrequently one makes the diag-
nosis clinically. As already stated, thrombosis of the coro-
nary artery, especially with infarction of the heart muscle,
may simulate acute abdominal conditions. The same is true
of thrombosis of the mesenteric vessels; in the latter, pain,
tenderness and rigidity of the abdomen may be accompanied
by shock and later fever.

Circulatory stasis in the abdomen is shared by the *kidneys.*
The urine is decreased in amount, is of high specific gravity,
and contains albumin and casts. In intense congestion there
may be *hematuria.* This may result also from embolism in
mitral stenosis and auricular fibrillation. Impaired elimina-
tion is shown not only by the dyes but by decreased excre-
tion of water and salt. In the subacute bacterial endocar-
ditis due to streptococcus viridans, the renal changes are
especially in the glomeruli and are often embolic. *Infarction*
of the kidney also occurs in this condition. When large
enough to cause tension, it leads to severe pain with tender-
ness, localized especially in the corresponding lumbar region

and is associated with blood in the urine. *Menorrhagia* and *metrorrhagia* are not uncommon findings, even where the amount of cardiac failure is not marked. The passive congestion of the pelvic organs may lead to dysmenorrhea, amenorrhea and leucorrhea. There are many symptoms due to disturbed blood supply to the brain. Headache, vertigo and flashes of light, are common in aortic incompetence. Vertigo is more apt to recur in sudden changes from the recumbent to the upright position. It is common in elderly people with sclerotic arteries; fainting occurs in aortic disease, but it is commoner in heart block with sudden slowing of ventricular rate. When associated with fits, it constitutes the Adams-Stokes syndrome. Syncope may also occur where the ventricular rate rises to an extreme degree; it occurred recently in a patient with auricular fibrillation under treatment with quinidin. As the auricular rate fell, there was, for a brief interval, apparently a ventricular response of excessive rate; when the patient recovered from the syncopal attack there was the first return of normal rhythm that we had been able to detect. Sleeplessness and disturbed dreams are common symptoms; mental depression is not rare. Abnormal noises in the ear, especially if it is the seat of some atrophic catarrh, is distressing, especially in the hypertension cases. Retinal hemorrhages may occur.

The symptomatology of cardiac irregularities is given in the section on that subject.

The combination of symptoms depending upon myocardial failure are many: the commonest type of heart failure is that with congestion; here *breathlessness* is an early and conspicuous symptom; in its wake come cyanosis, moist râles at the bases of the lungs, engorgement of the veins of the neck, enlargement of the liver, ascites, increasing edema and suppressed kidney function. Auricular fibrillation is a common complication. Occasionally, edema may be more conspicuous than the breathlessness in the course of the failure. In another group we have heart failure with pain; the patient may succumb in a severe attack of angina pectoris without ever having shown any sign of congestion or edema. This grave form of heart failure fortunately is

less common than the ordinary cardiac pain, which warns of an over-taxed myocardium. Cardiac pain may vary from substernal oppression to the picture of grave angina pectoris; though more common in aortic disease, it may occur in any valve disease to some extent; it is precipitated by exertion and disappears when the patient rests, especially when it is an early manifestation. It suggests a line of treatment; restricted activity on the part of these patients will prolong their lives. Where pain tends to recur, though it may not be severe enough to pass for the paroxysmal variety, sooner or later dyspnea will be added to the pain and later the other symptoms leading to failure with congestion. On the other hand, the pain may become paroxysmal and severe and the patient succumb by failure with pain.

THE DIAGNOSIS OF HEART DISEASE.

A careful history and complete physical examination are important in cardiac diagnosis. The close relationship between the rheumatic group and heart disease is well recognized. It is important, therefore, to determine whether there is an antecedent history of rheumatic fever, chorea, tonsillitis, growing pains in childhood, scarlet fever, puerperal sepsis, diphtheria, erysipelas, whooping-cough, pneumonia, syphilis, or any other acute infection. Local foci of infection are potential causes of primary acute endocardial trouble or of recurrent endocarditis in old valve lesions. Fortunately, the faddishness seems to have died down, even among the laity; the x-ray films are interpreted in connection with other findings and fewer sound teeth are sacrificed foolishly than formerly. We have learned that in marked arteriosclerosis, essential hypertension and contracted kidney, the heart is not sound. No heart working against persistent high blood-pressure—one hundred and sixty in young adults or one hundred and eighty in the aged—can remain uninjured. Endocrine gland disturbance may have a decided deleterious influence on the heart, as is shown in hyperthyroidism. It is hoped that the widespread determination of basal metabolism may lead to an earlier diagnosis of hyper-

thyroidism and save the heart cells from the injurious influ-
ence of thyroxin.

A permanently enlarged heart is a diseased heart; the en-
largement may be due to hypertrophy, increase in its muscle
mass, or dilatation—that is, stretching of its walls and en-
largements of its cavities. In contrast, stand the hyper-
trophy found in old aortic insufficiency and contracted kidney
and the dilatation occurring in a few hours or days in parox-
ysmal tachycardia of some duration. In chronically enlarged
hearts varying degrees of hypertrophy and dilatation coexist.
A certain amount of dilatation when extra work is thrown
upon the heart is normal, according to Starling, but evidently
there is a pathologic dilatation in which the heart recovers
with difficulty or fails to recover. Any attempt at determin-
ing the relative value of hypertrophy and dilatation in chronic
heart disease today clinically is at least unnecessary. The
determination of fixed enlargement suffices to show us that
we have a diseased heart.

Means of Determining the Size of the Heart. The size of
the heart in normal individuals varies with their body weight,
age, sex, circumference of chest and position of the body.
Strong muscular development means a larger heart for the
individual than in one of soft fiber. The closest and most
permanent correlation is between the body weight and the
weight of the heart; all clinical methods of estimating the
size of the heart are only approximate. The *orthodiagraphic
method*, in the hands of the well trained, is one of the most
exact methods used today. The only objections to it are
the special apparatus and skill required, the time consumed
and the uncertainty of working with a mobile organ. Clay-
tor and Merrill[104] studied men in the vertical position with
the orthodiagraph and compared the weight of the patient
with the transverse diameter of the heart's shadow. In men
from one hundred and nine to one hundred and seventeen
pounds the average transverse diameter was practically eleven
centimeters. It rose gradually with each increment of ten
pounds in weight to thirteen centimeters in men from one
hundred and sixty-eight to one hundred and eighty-one
pounds. The *teleroentgenogram* is exact and quick; the pic-
ture of the heart is preferably taken with the tube two meters

from the patient to minimize optical distortion of the rays. With exposures made at twenty-eight inches, one centimeter should be deducted from the greatest transverse diameter of the heart shadow to make it correspond with the true or long distance silhouette referred to above. Le Wald[105] finds the greatest normal transverse diameter from thirteen to fourteen centimeters, exposure being made at a distance of twenty-eight inches. In the long distance exposure he finds the apex point from the median line is eight centimeters in the average normal individual; likewise if the right border is three centimeters from the median line it corresponds to the average sized individual. Bardeen[106] has investigated the size and weight of the heart in large groups of normal children and adults. Some of his deductions are that the most accurate size of the heart is the square surface of the teleroentgenogram; this is quickly estimated by the planimeter; he finds that there is a constant relationship between body weight and the size of the heart, and points out that the transverse diameter of the heart and the great vessels are the most objective obtainable. For the sake of simplicity, clinicians and roentgenologists largely confine themselves to these diameters in interpreting x-ray silhouettes. The following facts are culled from Bardeen's[106] paper: In infants of normal weight at birth the greatest transverse diameter of the heart shadow is five centimeters. At one year it has increased to seven centimeters. From one year to fourteen years it gradually rises to eleven centimeters, which is the adult lower level. In a normal adult of one hundred pounds the greatest transverse diameter of the long distance shadow is eleven centimeters. Increasing parallel with increasing weight it rises to fifteen centimeters at two hundred pounds. From two hundred to three hundred pounds it slowly attains a maximum of sixteen and one-half centimeters. If one's general impression be correct, that the majority of normal people will vary somewhere between one hundred and twenty and one hundred and eighty pounds, then twelve to fourteen centimeters will be satisfactory numbers to bear in mind as representing the variations in the normal transverse diameter in the teleroentgenogram. In x-ray shadows, in cardiovascular subjects, we must also study

the great vessels; here again the transverse diameter is probably the most useful index. For reference the table of Vaquez and Bordet[107] is added.

TABLE OF THREE DIMENSIONS, VAQUEZ AND BORDET.

Normal subjects. Men		Standing position	
Age	Transverse diameter in cm.	Chord of aortic arch in cm.	Diameter of ascending aorta in cm.
16 to 20 years	4 to 5	0 to 2.5	1.5 to 2
20 to 30 years	5	2.5	2
30 to 40 years	5 to 6	2.5 to 3.3	2 to 2.5
40 to 50 years	5.5 to 7	2.8 to 3.5	2.5 to 2.8
50 to 60 years	6 to 7	3 to 3.7	2.5 to 3
Over 60 years	6 to 8	3 to 4	3

In this table the transverse diameter is that of the arch of the aorta, and means the maximal distance which separates the contours of the aortic shadow on the right and left of the sternum. The chord of the aortic arch means "that part of the arch where it issues from the mediastinal shadow and begins its outline on the left pulmonary field to its intersection with the pulmonary artery below." Let us emphasize again that since the size of the heart varies with weight, age, sex, muscular development, and position of the body, whether upright, sitting, or prone, also in systole and diastole, x-ray silhouettes are approximate. However, with the systematization of methods, more accurate deductions are drawn than formerly. One of the greatest stumbling blocks to the adoption of a uniform method is the difficulty of position. Many patients cannot stand erect long enough for taking the x-ray shadow, and in the recumbent position the heart is larger, and the difficulty of placing the tube six feet from the patient is greater. However, this striving for a quantitative standard gives more exact information than our old general impressions. The reason the heart is smaller in the standing than in the recumbent position is due to the changes of hydrostatic pressure in the inferior vena cava. From these mechanical methods of estimating the size of the heart, we will turn to our old methods of inspection, palpation, percussion, and auscultation.

Apex Beat or Maximal Impulse. The normal impulse is a sustained thrust, definitely palpable, in the fifth interspace, three to four and one-half inches from the median line of the sternum, and is confined to a small area. Lewis says the outermost part of the circumscribed area is our best clinical guide to the left border of the heart. It corresponds with the left limit of the orthodiagraphic silhouette in normal hearts or those but moderately enlarged. In greatly enlarged hearts it is a guide to the size, but not to its left border.

The midsternal line is the most accurate point from which to measure the apex beat and the borders of the heart.

Distance midsternal line to maximum apex beat:

(1) Ordinarily given, 3½ to 4 inches (9 to 10 centimeters).

(2) Lewis[108] gives 3 to 4½ inches (roughly 7½ to 11½ centimeters).

Goodman,[109] studying recruits by inspection, palpation, percussion and auscultation, concludes that the size of the heart varies directly with the weight and chest measurement of the individual. Thus, according to his tables, from midsternum to the left border of the heart averages eight centimeters in men of one hundred and ten pounds, rising gradually with increase in weight to eleven centimeters at two hundred pounds. Again from midsternum to left border was eight centimeters in men with chest circumference of thirty inches, rising gradually to eleven centimeters with chest circumference of thirty-nine inches. These figures bear out the statement of Lewis that the usual three and one-half inches (nine centimeters) from midsternum to maximal impulse is not elastic enough.

A definite maximal impulse lying more than four and one-half inches to the left of the mid-sternal line is direct evidence of enlargement of the heart, especially if it lies in the sixth interspace.

Percussion will show approximately the size of the cardiac dullness. Define the left cardiac border by percussing from the axilla inward and compare with the outermost limit of the apex beat. To percuss the right border, first find the upper level of liver dullness and percuss inward just above

this.   Definite cardiac dullness to the right of the sternum means displaced heart or engorged right auricle.

Cardiac Murmurs.

Diastolic Murmurs. Though systolic murmurs are far more common, the detection of diastolic murmurs in auscultation is decisive evidence of heart disease. A diastolic murmur at the base, usually in the second right interspace, often in the second interspace to the left of the sternum, transmitted down the borders or body of the sternum to the apex beat, is often a sign of aortic regurgitation. In early cases the murmur is frequently heard to the left. In young adults, rheumatic fever is a common cause; in middle life, syphilis. The full diagnosis and differential diagnosis of aortic incompetence is considered under that heading.

A diastolic murmur at the apex means organic heart disease, usually mitral stenosis. Occasionally further study may show that this diastolic murmur originates at the aortic area. The differential diagnosis will be found under the diagnosis of aortic incompetence. For the sake of emphasis we may here repeat that the characteristic murmur of mitral stenosis is a diastolic murmur; it may be early, it may be middiastolic, and a presystolic element may or may not be present. Again, the murmur of mitral stenosis may begin soon after the second sound and run through the whole of diastole.   The subject is discussed more in detail under the head of mitral stenosis.

Systolic Murmurs. In auscultating the heart, systolic murmurs are far commoner but they are decidedly less helpful in diagnosing organic heart disease.   The cardio-respiratory murmur is the commonest; it may be heard best at the apex, over the precordium, or even at the angle of the left scapula. It is of short duration, high pitched and heard best during inspiration.   It disappears when the breath is held, as it is probably a breath sound rather than a murmur.   It is of no importance diagnostically. The next commonest systolic murmur is heard at the pulmonary cartilage, especially when the patient is recumbent.   It may be heard as low as the apex.   Unlike the systolic murmur of pulmonary steno-

sis, it is inconstant, does not show the transmission along the lines of the clavicle, is not accompanied by a thrill in the region of the pulmonary cartilage and there is no history of cyanosis in the patient. The causes of this murmur are given under the heading of pulmonary valve disease.

Aortic Systolic Murmurs. A systolic murmur heard best at the second right cartilage, extremely rarely means aortic stenosis; more often it means stiffening of the valves, roughening of the intima of the aorta, or some abnormal hemic state. Especially in men past middle life, with dilatation of the ascending aorta, the aortic systolic murmur may be harsh or musical, but the ringing second sound differentiates it from stenosis. In the rare genuine aortic stenosis of old men a thrill of greatest intensity is found at the base of the heart; a rough systolic murmur with maximum intensity at the aortic cartilage is transmitted to the great vessels, and the pulse tracing is flat topped. Commonly aortic stenosis is associated with some aortic incompetence. The important thing to bear in mind is that an aortic systolic murmur seldom means aortic stenosis.

Tricuspid Systolic Murmurs. Their maximum intensity is in the ensiform region. They may be provoked by strenuous exercise. In cardiac failure engorgement of the veins of the neck and systolic pulsation in them are more important than a murmur.

Mitral Systolic Murmurs. Formerly a systolic murmur with maximum intensity at the apex and transmitted into the axilla was considered diagnostic of mitral incompetence; clinical, combined with post mortem, experience has shown this conception to be often fallacious. Furthermore, murmurs of exactly the same quality occur with crumpled valves, in the insufficiency due to a relaxed ring, and with no demonstrable lesion at post mortem at all. Clinically, it is impossible from the murmur alone to say whether it is due to valvulitis, or to a relative insufficiency of the mitral opening. A systolic murmur at the apex suggests that we search for an antecedent history of rheumatic disease or some similar infection in the patient's history and that we should try to discover a diastolic murmur also in this patient. For we remember that mitral incompetence and mitral stenosis

may often coexist, that a diastolic murmur at the apex is evident in mitral stenosis, that such a murmur is best heard with the patient in the left lateral position, and that where absent it may frequently be brought out by exercise. Furthermore, a systolic murmur at the apex, which is constant from day to day, is more likely to have an organic basis. Again, in genuine mitral disease of any standing we may expect the electrocardiogram to show auricular hypertrophy and right ventricular preponderance.

Chronic Myocarditis.

The term "myocarditis," though in disfavor for some time, owes its revival to the insight which the newer instruments of precision give concerning the changes of myocardial function. Acute and chronic myocarditis probably would be better reserved for those hearts in which the morbid changes are clearly due to infection, as rheumatic fever. In the changes wrought by arteriosclerosis, the term "myocardial degeneration" may be better; in any case, chronic myocardial disease may be diagnosed when the heart is definitely and permanently enlarged. This is true whether the enlargement is secondary to aortic disease, or to hypertension, essential or renal. In auricular fibrillation, auricular flutter, heart block and alternation, chronic myocardial disease exists. In well established aortic incompetence, even if simply rheumatic in origin, there is an invasion of the myocardium. When the aortic lesion is luetic, there is not only involvement of the myocardium and valves, but of the first portion of the aorta and the coronary arteries. The same chronic myocarditis exists in well established mitral disease, for about half of these cases develop auricular fibrillation. The greater number of patients with aneurism die not of rupture but of heart failure, again pointing to an unsound myocardium. As has been said, heart failure in a heart the seat of one or more valve lesions is due not to the valvular disease itself but to the final failure of the myocardium. In genuine angina pectoris we may find an enlarged heart or a heart that appears normal in size and function except for pain. In this disease there is de-

generation, not only of muscle but of coronary arteries. It is a disease of middle or advanced life and is often provoked by some unusual exercise; the more definitely the pain is substernal, at least in its beginning, the more apt is it to be of the genuine variety. Alternation of the pulse and signs of organic heart disease are often, but not always, present. The full consideration of angina pectoris belongs to another section.

Cardiac Arrhythmia.

We have seen that cardiac arrhythmias may be differentiated both by graphic methods and by the simple methods of examination at the bedside. We may review the latter briefly, focusing the attention upon cardiac rhythm and rate, especially at the apex.

Sinus Arrhythmia. Sinus arrhythmia is a condition found in children and young adults. It is closely connected with respiration, the pulse rate increasing during inspiration and decreasing during expiration. This form of arrhythmia may be exaggerated by deep breathing, and is abolished by anything which increases the pulse rate, as exercise or fever. It is rarely found with a pulse rate of one hundred and twenty or above.

A premature beat or extra systole may be recognized by its early appearance, by a pause which is compensatory or short of it, by the weakness of the heart sounds—sometimes the second sound being absent—and by the weakness or absence of the radial pulse. They are more commonly present when the pulse is at the ordinary rate, and the patient is upright. They are abolished by anything, like exercise, which increases the pulse rate. Ordinarily being wiped out by a rate of one hundred and twenty to one hundred and forty, they are prone to show themselves in the period following exercise and after a period of holding the breath. More often graphic methods are necessary to differentiate auricular from ventricular premature beats.

Heart Block. Simple prolongation of conduction is usually accurately demonstrated only by exact methods. In the grade of heart block where there is an occasional, or regularly recurring dropped beat, the irregularity is to be dif-

ferentiated from premature beat thus: On listening at the apex, instead of a premature beat, one will find silence over the heart almost twice as long as the normal interval. A regular pulse rate of fifty may be bradycardia, but it suggests block. A regular pulse rate of forty suggests two-to-one heart block. In complete block the ventricular rate is usually thirty. It may be less, occasionally it is more, especially when the impulse arises high up in the bundle.

Two-to-one heart block may be difficult to differentiate from a slow normal rhythm, but two-to-one heart block is an unstable condition. Sudden halving or doubling of the pulse is suspicious. Again, in two-to-one heart block, by means of posture, exercise, or atropin, we may be able to change the grade of the block or abolish it. Higher grades of block, as three-to-one and four-to-one, are still more unstable and tend to pass into complete block.

Paroxysmal Tachycardia. A regular apex rate of one hundred and fifty and above, uninfluenced by any change in posture of the patient, and unassociated with any of the usual toxemias causing simple tachycardia, especially if there is a subjective history on the part of the patient of the onset and offset, tends to fix this condition as of the paroxysmal variety.

Auricular Flutter. We have curves where the patient with a regular rate of seventy-five showed, when examined graphically, that there was an auricular rate of three hundred, and there was four-to-one block. This illustrates the difficulty of saying that the patient has flutter unless he is examined by exact methods. However, there are some differences which point to the diagnosis between paroxysmal tachycardia and auricular flutter. Auricular flutter, when once established, is apt to be a permanent condition. Simple paroxysmal tachycardia, on the other hand, comes in spells, as its name implies.

The rate in auricular flutter is more easily influenced by position, exercise, and drugs, than in paroxysmal tachycardia. The reaction of the two abnormal mechanisms to digitalis is interesting. We have curves of a man who, with auricular flutter seven years ago, was given digitalis, which produced auricular fibrillation, and today he is still fibrillating. In paroxysmal tachycardia, on the other hand, digitalis

never slows the rate, but it sometimes seems to help abolish the paroxysm.

Alternation is characterized by alternate stronger and weaker heart beats. It shows best in a sphygmogram.

Where alternation is a permanent feature, it can be demonstrated by the sphygmomanometer.

Adjust the apparatus as if you were taking blood-pressure. Near the point of systolic pressure, either every other beat comes through as a weak one, or fails to be heard until you have lowered the mercury in the column some twenty or thirty millimeters.

Auricular Fibrillation. A persistent irregular rhythm of the heart, with a pulse rate of one hundred or above, is almost always auricular fibrillation. It is the maximal irregularity of the heart, and once established it is usually permanent. At the apex one hears a jumble of loud and weak sounds with varying pauses. The count at the apex and the count at the radial do not agree, or often do not—there is a pulse deficit. In slower fibrillation, with a pulse around eighty, there may be difficulty in differentiating this irregularity from extra-systolic arrhythmia. Exercise the patient, and when you raise the rate to one hundred and twenty or above, the arrhythmia of auricular fibrillation increases, the other disappears.

After exercise the irregularity of auricular fibrillation grows less with fall of pulse rate, but the irregularity of extrasystolic arrhythmia increases with fall in pulse rate.

Tests of Heart Function.

There is no satisfactory method of estimating cardiac function, though many have been suggested. Barton,[110] in his manual, and Kahn,[111] in the Medical Clinics of North America, have given a summary of the methods. Change in posture and simple graded exercises, such as stair climbing, hopping on each foot alternately, squatting, raising oneself on a chair and raising dumbells, all cause the cardiac rate to accelerate, but the reaction should not be excessive and the apex rate should return to normal in two minutes in the normal heart. Accompanying

the increase in heart rate there will be a certain amount of
breathlessness. If this is excessive and the apex rate delays
in returning to normal there is evidently a loss of cardiac
reserve. Dr. William D. Stroud kindly allowed me to in-
clude in an article on the diagnosis of heart disease,[112] in
the International Clinics last year, the observations he made
upon twelve young, healthy adults who were subjected, as
will be seen, to different exercises. The results we will take
from the paper.

His object was to find their responses to varying grades
of exercise. The same men were put through the four ex-
ercises. In each table maximum is the individual who gave
the widest response, minimum is the individual who gave the
least response, average is an average of the twelve. Thus in
Table A, the average pulse rate before exercise was seventy-
five; after twenty hops on each foot it rose to ninety-one,
and in two minutes had fallen to seventy-six. In Table B
the average pulse rate before exercise was seventy-six,
rising to one hundred and one after fifteen squats, and fall-
ing to eighty-two in two minutes. In Table C the average
pulse rate before exercise rose from seventy-seven to one
hundred and four after twenty steps upon a chair, falling to
the original starting point two minutes after exercise. In
Table D, before exercise, the pulse rate was seventy-seven;
after twenty lifts of two fifteen-pound dumbells the pulse
rate was one hundred and eighteen, and fell to ninety-one
in two minutes. These tables illustrate an ascending grade
of severity of exercise, which may be useful in trying to
force out the diastolic murmur of mitral stenosis as well as
testing the heart's reaction. They further illustrate a very
important point, and that is the desirability of studying the
effect on the individual as well as on his pulse rate. So that
you will see that Dr. Stroud has found that the number
showing breathlessness after the varying degrees of exercise
increases in proportion to the severity of the exercise. In
stepping upon the chair, the man places his foot squarely
upon the chair and raises himself to a full erect position the
twenty times. The dumbells are raised from the floor to the
full length of the arms above the head, at the rate of one
lift in two seconds. The average increases in rate in Stroud's

A.

130

120 — AFTER TWENTY HOPS ON EACH FOOT

110

PRE-EXERCISE RATE.

100

MAX.

90

AVER.

80

MIN.

TWO MINUTES AFTER EXERCISE

70

PULSE = 10 NO. BREATHLESSNESS
2 SLIGHT "

B.

130

120 — AFTER FIFTEEN SQUATS.

110

PRE-EXERCISE RATE

100 — MAX.

90 — AVER.

80 — MIN.

TWO MINUTES AFTER EXERCISE.

70

PULSE = 4 NO BREATHLESSNESS.
8 SLIGHT "

C.

130 — AFTER TWENTY STEPS UPON A CHAIR

120

110

PRE-EXERCISE RATE

100 — MAX.

90 — AVER.

MIN.

TWO MINUTES AFTER EXERCISE

80

70

PULSE = 1 NO. BREATHLESSNESS.
11 SLIGHT "

D.

130 — AFTER TWENTY LIFTS OF TWO FIFTEEN POUND DUMBELLS.

120 — MAX.

110 — AVER.

PRE-EXERCISE RATE.

100 — MIN.

TWO MINUTES AFTER EXERCISE.

90

80

70

PULSE = 9 SLIGHT BREATHLESSNESS.
3 CONSIDERABLE "

Fig. 49.

tables were: after twenty hops on each foot, sixteen, with return to normal in two minutes; after fifteen squats, twenty-five, with almost a return to normal in two minutes; after the chair test, twenty-seven, with return to normal; in the dumbell tests, forty-one, with a pulse fifteen points above normal at the end of two minutes. In patients with impaired hearts there will be a sharper reaction in rate, slower return to normal level, and the breathlessness and distress will be in excess of that found in a normal individual for the given exercise.

The heart beats more slowly, by from seven to fifteen beats, in the recumbent than in the erect position. This difference is diminished or altogether lost in cases of incompetent valvular disease, or when the heart is seriously weakened. The normal increase from recumbency to a standing position should not be more than twenty beats per minute.

PROGNOSIS IN HEART DISEASE.

There are certain general factors in the patient's history which have a distinct bearing upon the outlook. In the first place, the occupation of the cardiac patient is of great importance, whatever the type of heart disease. From the point of occupation, the stevedore, from the sudden strain he must put upon his cardiovascular system, is worse off than the clerk. Formerly, one used to encounter baggage handlers with well developed aortic lesions; on the one hand, the industrial examination tends to eliminate these men from posts unsuitable to them; on the other hand, the awakening interest in cardiac disease, as evidenced by the number of associations for the prevention and relief of cardiac disease over the country, will ultimately bring the man into contact with the position which he is able to hold with safety.

The average general health of the individual is a factor. Patients with repeated attacks of tonsillitis, of rheumatic fever, however mild, and recurring respiratory infections with much cough, naturally are not in as good a position as those whose average health is better. A family history of early cardiovascular degeneration is sometimes elicited. Occasionally, one sees a patient succumb at thirty-five with

arteries as hard as many a man of eighty. In some of these patients there has been an antecedent history of acute infectious diseases which probably laid the foundation of arterial degeneration many years before. The habits of the patient have an important bearing. In abusers of alcohol and tobacco the outlook is not so good. There is a general tendency to look upon nicotine as a cardiovascular irritant. The common practice of inhalation is bad because it offers a much larger area for the absorption of the poisonous principles of tobacco smoke. There are no statistics to show that the moderate use of tobacco is an actual cause of cardiovascular disease, but that its abuse is deleterious to people with and without cardiac disease seems well founded. Halsey[113] gives us interesting facts, drawn from medico-actuarial investigation. In the obese the mortality for a given age rises progressively as the weight increases and the circumference of the waist-band exceeds the girth of the chest. The outlook is more serious in those who have a hereditary tendency to obesity than those who acquire a moderate obesity at thirty-five or forty and continue their physical activities. Acquired obesity after fifty years offers a still worse outlook from the cardiac standpoint. Obese patients stand pneumonia badly. They frequently develop cardiac failure. With respect to age, in cardiac patients for every period of ten years above twenty-five the mortality rate more than doubles. Practically one-fifth of all deaths and eighty-five per cent. of deaths which occur after forty years of age, are due to heart disease. With respect to sex, up to twenty-four years the death rate is greater among women; above that age, the death rate from heart disease is greater among men. With respect to race, the mortality statistics of insurance companies show that the negro is more frequently afflicted with heart disease than the white. In the age periods, one to five, and thirty-four to fifty-six, the mortality among negroes is double that among white people. However, the mortality in patients with severe cardiac pain, in the white race, is already increasing and is now more than twice that of the negro, another evidence of the white man's burden. The comparatively care-free attitude of the negro toward life may be a saving factor for him. Certainly, he is not immune from

23

the underlying infective factors which cause myocardial degeneration.

In passing upon the individual case, it is not sufficient to examine the heart alone; one must make a general survey of the patient. If one finds a history of *acute rheumatic fever* in the patient, he may feel sure that almost always there is some valvular and not unlikely some myocardial involvement. The original attack may have entirely subsided, but one has to bear in mind that these patients are often subject to recurrent endocarditis. If the patient has had no recurrence of infection for a period of three years, especially if this is after puberty, it seems safe to assume that the infection has died out. In rheumatic patients where a focus of infection has been discovered and has been eliminated, the outlook is better.

Syphilis is insidious in its effect upon the heart. An infection, acquired many years before, may reveal itself to ordinary clinical means only in middle life. It is particularly dangerous because it tends to involve the first portion of the aorta and the coronary arteries, which leads to decided myocardial involvement. Early diagnosis and thorough treatment offer a decidedly better outlook, but, as so often happens, if the disease is not diagnosed until aortic insufficiency and cardiac hypertrophy are evident, naturally the future is jeopardized. Sometimes the clinical history may help where the ordinary laboratory examinations fail. Some time ago I saw a patient, a woman of about forty, with thoroughly well developed aortic insufficiency, with no history of the rheumatic group, and yet her blood Wassermann was negative. It was only later learned that she had borne a child by a former husband, which early became blind.

A permanently enlarged heart is often associated with hypertension, whether due to renal or arterial disease. Such hearts are the seats of degenerative changes and the outlook depends upon the myocardium in part and in part upon the functional impairment of the kidney. Ofttimes, the latter factor is the more serious, and its full discussion will be found in the section on renal disease. Grave factors are: a constant low and fixed specific gravity of the urine, decreased chloride and phenolsulphonephthalein elimination, decreased CO_2

combining power of the blood plasma and an increase of the urea nitrogen and creatinin found in the blood. When creatinin is present in the blood in proportion of five milligrams per one hundred cubic centimeters and over, every nephritic succumbs in a few days to two months. Abnormal accumulations of blood urea, uric acid and creatinin foretell uremia, while a subnormal CO_2 combining power of the blood points to acidosis. In some of the patients under discussion, however, the terminal event is cerebral hemorrhage.

Chronic Valvular Disease. In chronic valvular disease the outlook depends upon the degree of compensation. If the ventricles hypertrophy sufficiently to meet the new load, the patient may go on in comparative comfort indefinitely, irrespective of the valve involved. Aortic valve lesions are the most serious. Here the base of the aorta and the coronary arteries are commonly also affected. This leads to myocardial degeneration. Aortic disease due to syphilis or arterial sclerosis is more apt to involve the base of the aorta than if due to rheumatic fever. In some cases, compensation may be perfect and the patient lead a comfortable life for some time. On the other hand, myocardial degeneration is almost always progressive in these cases, and sudden death is more common in this valve lesion than in any other. This is more commonly due to blocking of a coronary branch but it may occur from acute dilatation on over-exertion. It is the valve lesion most commonly associated with severe anginal pain, and occasionally auricular fibrillation, both of which add to its gravity.

In mitral stenosis the outlook is rendered more serious because the myocardium is almost always involved and these valves are often the seat of recurrent endocarditis. Occasionally mitral stenosis may be found in people who seem to be in perfect health, but with the narrowing of the orifice, increasing dyspnea and beginning signs of heart failure appear. The majority of these patients succumb between thirty-five and forty years of age. It is rendered more serious by its close association with auricular fibrillation and by its tendency to embolism. Mitral insufficiency appears to offer a better prognosis. Pulmonary insufficiency and tricuspid valve disease are commonly associated with mitral valve

disease and add to the gravity of the prognosis. Chronic myocardial disease exists in aortic incompetence, in mitral stenosis, in chronic enlargement of the heart, in association with aortic aneurism, and where pulsus alternans, heart block and fibrillation or flutter of the auricles exist. The symptoms include dyspnea following exertion, and in more advanced cases there may be orthopnea, paroxysmal dyspnea and moist râles at the bases. Constant alternation of the pulse is looked upon as bad prognostically. When it occurs for a few beats after a premature beat, it is also of ill omen. Especially when alternation is associated with symptoms of cardiac failure, its gravity is enhanced.

Chronic auriculo-ventricular heart block is ordinarily a local expression of a widespread myocardial involvement. High grade block may lead to Adams-Stokes syndrome, with increased danger. Intraventricular block, also called arborization block or subendocardial myocardial disease, constitutes a group with a very bad outlook. According to Willius,[28] an inverted T wave in the electrocardiogram, in a patient who has not been taking digitalis, means a high mortality. The mortality was greater where the T negativity occurred in Leads I and II. However, the mortality was almost as great with a negative T in Lead I. It seemed of much less importance in Lead III. Acute myocarditis may be revealed in the electrocardiogram, especially by prolonged conduction. This often occurs in acute infections and often clears up.

Vital Capacity of the Lungs. Peabody[114] and his co-workers have developed this subject and shown its clinical value in the prognosis and diagnosis of heart disease; they define vital capacity of the lung as "the greatest amount of air that can be expired after a maximum inspiration"; they have determined the vital capacity of the lungs in healthy individuals and have established working, normal standards, and given us the table on page 357.

Normal individuals are said never to fall below ninety per cent. of the normal standard; on the contrary, they may rise above normal. In heart disease it was found that there was a distinct relationship between the degree of dyspnea and the amount of decrease in the vital capacity of the lungs.

MALES.

Height in feet and inches	Normal vital capacity	
	Cubic cent.	Liters
Over 6 ft.	5100	5.1
5 ft. 8½ in. to 6 ft.	4800	4.8
5 ft. 3 in. to 5 ft. 8½ in.	4000	4.0

FEMALES.

Height in feet and inches	Normal vital capacity	
	Cubic cent.	Liters
Over 5 ft. 6 in.	3275	3.275
5 ft. 4 in. to 5 ft. 6 in.	3050	3.05
Under 5 ft. 4 in.	2825	2.825

That the vital capacity should be decreased in advanced heart disease with effusion into the serous sacs, pulmonary edema, enlarged heart, ascites and enlarged liver, was self-evident, but they soon found that there were earlier cases of heart disease with a moderate amount of reduction of vital capacity, where the above conditions were practically absent. The decrease in vital capacity in these early cases was attributed to sluggish pulmonary circulation; the congestion of the pulmonary vessels leads to a loss of elasticity of the lungs, so that they no longer expand and collapse normally in respiration. Peabody and Wentworth,[115] in a series of observations carried out on patients with various types of cardiac disease, found that there was a close relationship between the decreased vital capacity of the lungs and the severity of the heart's impairment, especially as evidenced by the degree of dyspnea. They were able to divide their cardiac patients into four groups, according to their impairment in vital capacity. In group one, the vital capacity was ninety per cent. or more, of the normal standard. These patients were without any symptoms pointing to cardiac involvement. In the second group were patients with a vital capacity between seventy and ninety per cent. of normal. All these were limited in their activities because of a ten-

dency to dyspnea on exertion. In the third group of patients the vital capacity was from forty to sixty per cent. of normal and here dyspnea, even on moderate exercise, was prominent; very few of these patients were able to work, but among this group other evidences of heart failure began to appear and the mortality was high. The fourth group consisted of those with à vital capacity of forty per cent. of normal or less. They were mostly bed-ridden because of cardiac failure and some had dyspnea even at rest. Patients with a vital capacity below forty per cent. may show an improvement if this occurs during their first attack of heart failure, but apparently so low an index during later attacks is an unfavorable sign.

Again, Peabody and McClure[115] studied a series of patients and compared the changes in the vital capacity with those of the clinical condition. The latter were based largely upon the degree of dyspnea, cyanosis, edema, pleural effusion, pulmonary congestion, enlargement of the liver, ascites, pulse rate and pulse deficit. They found that the variations in the vital capacity of the lungs and the tendency towards dyspnea ran parallel and were indirect indices of the cardiac condition. Rise in vital capacity was associated with improvement in the patient, whereas a fall in vital capacity was accompanied by symptoms and signs of deterioration in the patient's condition. Thus, a series of daily determinations of vital capacity of the lungs, if charted, are objective signs of the clinical course of the patient, that are valuable in prognosis. The Sanborn Vital Capacity Spirometer (Fig. 50) was designed according to the suggestions given by Dr. Peabody in an earlier paper. It is extremely simple to use and comparatively easy to move about the hospital, where it finds a larger field of usefulness than in the office. Full directions for its use are furnished with the instrument.

Mackenzie[116] has written upon the relation of *heart disease and pregnancy*. He finds the signs of cardiac distress in pregnant women are breathlessness and palpitation. Pain on effort may be present in certain cases of mitral stenosis and aortic disease, but the pain of grave heart failure is usually lacking. No single sign shown by the heart itself should be a bar to pregnancy. All systolic murmurs in hearts

which show no other abnormal sign should be ignored if the patient's response to effort is good. If systolic murmurs are associated with other signs of heart disease, the prognosis is based upon these other signs and not upon the systolic murmurs. The same rule applies to arrhythmias which are respiratory or due to extra systoles. In women who complain of precordial pain of varying intensity, whose hearts are easily excitable, pregnancy may be allowed if the heart is normal in size or only slightly enlarged. This applies whether systolic murmurs are present or not. Mitral steno-

Fig. 50.—Sanborn vital capacity spirometer.

sis is the form of heart disease which occasions the greatest anxiety in pregnant women. Here there are two groups of cases: the dangerous and the non-dangerous forms of the malady. In the non-dangerous group the cicatrizing process, which produces the stenosis, is stationary or making but slow progress. Such slow progress is shown by the character of the murmur. If there is present ten or fifteen years after the attack of rheumatic fever, only a presystolic murmur and if the heart size is normal, its rate regular and the response of the patient to effort good, then pregnancy may be undertaken with fair prospect of safety. In the dangerous group there is present, within a few years of the attack of rheumatic fever, a diastolic murmur as well as a presystolic; the danger will be increased where the heart is enlarged and effort causes distress. When in addition to the mitral steno-

sis there is fibrillation of the auricle, pregnancy should be forbidden. If pregnancy has taken place, then the patient should be watched and if grave signs of heart failure occur, then, at least from a medical standpoint, pregnancy should be terminated. In cases of aortic insufficiency, if the heart is normal in size and its response to effort good, pregnancy may be undertaken. But if the ventricle is much hypertrophied, and if the pulse is markedly "Corrigan," the probability is that the heart will be so permanently impaired that it will cripple the patient severely if she gets over the confinement.

Operations On Cardiac Patients. Some of my surgical colleagues at the Presbyterian Hospital in the last few years have permitted me to examine cases of clear or suspected cardiac disease with respect to the operative risk. But our series is entirely too small to draw conclusions. They are in accord, so far as they go, with the experiences of Blackford, Willius and Haines[117] in the Mayo Clinic. With respect to the immediate operative risk, patients with heart disease who are ambulatory stand operation well. Again, patients with the minor symptoms of failure on admission, who become ambulatory after treatment, usually pass through the ordeal safely. Patients with angina pectoris are bad risks. The same is true of aortic valvular disease and diffuse dilatation of the aorta, especially if associated with pain. In these three types of patient, operation is contraindicated unless under the most pressing circumstances. However, in aortic disease unassociated with angina or other signs of cardiac failure, a patient may be operated on with safety in case of need. In mitral disease, especially mitral stenosis with good compensation, operation seems comparatively safe. The cardiac arrhythmias show myocardial degeneration and yet, according to the writers quoted, patients with various forms stand operation well. For instance, in seventy cases of auricular fibrillation associated with exophthalmic goiter, the mortality was two, that is, two and eight-tenths per cent., whereas the normal operative mortality was two and six-tenths per cent. Again, four causes of auricular flutter were confined to bed, given vigorous digitalis treatment until fibrillation was brought about and then the operation was per-

formed safely in every case. Seven cases, of varying degrees of heart block, were operated upon safely and twelve patients with arborization block were successfully operated on with no deaths earlier than a year after operation.

Operation in cardiac cases must also be considered from the standpoint of removal of infections or toxic sources of cardiac poisoning. Now auricular fibrillation is a late manifestation of thyroxin poisoning, and yet in these patients the gross surgical mortality is five per cent., which is but a slight increase on the normal operative mortality. Naturally, the operation should be done in all toxic goiters long before they reach this stage, and certainly the mortality is negligible as compared with the disastrous degeneration of the heart subjected to constant poison. One may expect great improvement in the heart as well as the patient's general condition. Furthermore, the removal of infected tonsils is often followed by cardiac improvement.

Levy[118] concludes from animal experiments that especially under light chloroform anesthesia the heart is irritable, as evidenced by its tendency to show premature beats. In experiment this ventricular irregularity often terminates in ventricular fibrillation and death. The same irritability is not noticed when the patient is kept under deep anesthesia by chloroform. Levy[119] also found that injection of adrenalin under light chloroform anesthesia was apt to produce disturbance of rhythm in the heart, which finding has been confirmed by others. This suggests that in operation the use of adrenalin and chloroform at the same time is not advisable.

TREATMENT OF HEART DISEASE IN GENERAL.

There are many general considerations of importance in the treatment of cardiac patients aside from drug therapy. The patient's daily life should be inquired into, as his daily occupation is especially important to the cardiac patient. Tasks which cause too much physical exertion for the individual and produce breathlessness, palpitation, or perhaps even mild pain, are bad. The cardiac patient with a competent myocardium is safer in a sedentary occupation or in

one combined with physical activities well within his capa-
bilities.   Naturally, air, light and freedom from dust are
especially important for these patients.   One of the functions
of the associations for the prevention and relief of heart
disease is to stimulate agencies to secure proper occupations
for cardiac patients, especially those who have had at least
one breakdown that required a stay in a hospital.

That properly graded exercises are good for cardiac
patients with little or no signs of cardiac failure was amply
demonstrated among the convalescent troops in the late war,
by Lewis and his associates at Colchester and Heard at
Angers.   Furthermore, it is receiving proof daily at the hands
of Brush and others at the cardiac convalescent homes.
Patients allowed exercise must be selected ; where there are
mild symptoms of impending myocardial failure, as passing
breathlessness and pain on exertion, or an accelerated pulse
that does not return to normal promptly, exercise must be
used judiciously, and if it aggravates these primary symp-
toms it must be interdicted.   A period of complete rest in
bed may remove these symptoms, but if in spite of these
early signs of cardiac failure intense physical exercise is per-
sisted in, it may lead to an entire cardiac breakdown.   Where
there is an advanced degree of cardiac failure in chronic heart
disease, as evidenced by conspicuous dyspnea, cyanosis,
edema, and the other signs arising from passive congestion,
the patient must be confined to bed ; this is also true in acute
infections involving the heart.   The various forms of exer-
cises that may be carried out under medical supervision form
a chapter in themselves, but there are certain words of ad-
vice and warning that should be heeded by all cardiac suf-
ferers.   These patients should avoid extremes, but a quiet
exercise which tends to keep the skeletal muscles fit has a
beneficial influence upon the heart and circulation.   Walking
in the open country is one of the best forms, provided the
distance covered and the rate of walking cause no distress
but leave the patient with a comfortable sense of fatigue.
If it leads to uncomfortable symptoms, then the exertion has
been too much; its amount should be curtailed and there
should be a graded increase.   Another form of mild exercise
is the setting up exercises involving the arms and legs but

not the trunk. Barringer[120] recommends as energetic exercises for heart patients stair climbing, rope skipping, hopping, and dumbells, also calisthenic exercises. One hesitates to enter upon sports because they so easily lend themselves to competition, and competitive exercise is undesirable for the heart patient. He is constantly led into over-exertion for fear of being considered a poor sport if he does not keep up his end. He probably can go his own pace better in golf, and horseback riding is open to him. For the patient who drives his own car, especially long distances, motoring is often too laborious. With a chronic valve lesion but good myocardium, a patient may indulge in quiet swimming in water not too cold and a little rowing may be harmless. Certainly, tennis, especially squash, cycling, baseball, and football are too strenuous for these patients. A word of warning seems necessary to men in middle life. It is not an uncommon experience to find patients whose beginning feelings of easy fatigue are due to sclerotic vessels and heart. Unfortunately, these individuals attribute their ill feelings to a lack of exercise, so that they frequently plunge into activities unsuited to their condition with disastrous results. They seek institutes of physical culture and without medical advice take up forms of exercise which are too heavy and which increase their troubles. On more than one occasion I have seen rapid cardiac breakdown, following boxing and swimming in cold water, overtake these sclerotic individuals. According to the history of some, what had been a mere substernal uneasiness before was immediately converted into a well developed angina pectoris. The excessive use of tobacco, strong coffee and strong tea is undesirable for these patients. Excessive use of alcohol is likewise bad. A malt liquor may increase the appetite but consumed in large quantities it overloads the circulation. Where the patient is accustomed to using light wines they may be allowed; spirituous liquors in any amount are undesirable, but in those accustomed to their use a small quantity, well diluted, is often conducive to sleep in these patients, often wakeful. With respect to climate, if a choice is to be made, cardiac patients fare better in a comparatively warm, dry climate, such as southern California. Here, they are less

subject to catarrh of the respiratory system, and recurring rheumatic attacks. These patients should especially avoid too active exercise at altitudes to which they are unaccustomed. They rarely have troubles with the altitudes on our eastern seaboard, but at five thousand feet and above, they are liable to begin to experience discomfort.

The question of heart disease in pregnancy was considered under prognosis. Though the man is not exposed to the same danger as the woman cardiac by marriage, still, the greater activities that marriage may necessitate in providing for a family are to be considered. In aortic disease and marked hypertension coitus is not without danger.

In the early stages of cardiac failure, whether it be marked by increasing dyspnea, substernal distress, edema of the ankles, or even more evident signs, complete rest in bed for one or two weeks may suffice to restore the cardiac function. The question of diet in the early or in the later stages of heart failure is an important one. Even in the early stages, patients should avoid food which leads to meteorism, among these being beans, peas, cabbage, many other starchy foods and charged waters. The heavier meals should be in the morning and at noon; the evening meal should be light. A daily evacuation of the bowels adds to the patient's comfort. Especially when edema is present, fluid should be restricted, and an estimation of the intake and output is desirable. A daily intake of fifteen hundred cubic centimeters is usually sufficient where there is slight edema. When the edema is more marked, especially with effusion into a pleural cavity, eight hundred cubic centimeters should suffice. The Karell diet may give excellent results when edema increases in spite of other treatment, as it often leads to a marked increase in diuresis and reduction of the dropsy. Ordinarily it consists of giving two hundred cubic centimeters of milk at 8 A.M., 12 M., 4 P.M. and 8 P.M. daily for from five to seven days; following this, there may be added gradually, bread, vegetables, one or two eggs and finally a little meat. Salt should be restricted in patients with heart failure; a salt-free diet often helps to get rid of edema quickly.

Drug Therapy. A few patients with early failure will clear up upon rest and diet alone. More often drug therapy is

necessary. Digitalis is by all odds the most valuable drug
we possess in the treatment of heart failure. It has been
used in heart disease since Withering first introduced it in
1785. Its remarkable action in auricular fibrillation won for
this drug a reputation in heart disease long before it was
known that auricular fibrillation existed.

The Preparations of Digitalis. For oral administration the
powdered leaf, in capsule, and the tincture are satisfactory
preparations. The digitalis leaf should retain its activity in-
definitely and the tincture, with proper care, for several
months. On the other hand, the infusion deteriorates rapidly,
is less uniform in its activity and its taste does not com-
mend it. Since a single therapeutic dose of digitalis is prob-
ably entirely absorbed in six hours, and graphic evidence
may be obtained of its action in two to four hours after
administration, it is reasonable to expect that patients should
show some effect of the drug within twenty-four hours at
least. However, the powdered leaf and tincture, and even
the infusion, are usually readily absorbed, and furthermore
they are persistent in their action, their influence lasting
often for a fortnight. The only advantage of certain pro-
prietary preparations is their uniformity. Among these are
digitan—formerly known as digipuratum—digipoten, and
digitaline Nativelle. Digitan comes in tablets of $1\frac{1}{2}$ grains
each. Digitaline crystallized Nativelle is crystallized digi-
toxine, the most active principle of digitalis. It is uniform,
rapid of absorption, reliable and decisive in its action, there-
fore it should be used with care. It comes in granules of
$\frac{1}{240}$ grain and $\frac{1}{600}$ grain, also in ampoules of corresponding
strength. Digipoten tablets, one-half grain each, represent
one grain of the leaf.

The Action of Digitalis. Digitalis may produce marked
slowing of the pulse in auricular fibrillation, but where the
normal sinus rhythm is present, the slowing is not so marked
except in digitalis intoxication. Digitalis slows the heart
beat by its influence upon the vagus center in two ways:
Vagal stimulation causes depression of the rate of the im-
pulse formation in the sinus node, which leads to a slowing
of the whole heart; and it also causes depression of *A-V*
conduction, which may produce almost any degree of heart

block.   Lewis has recently demonstrated that in auricular
flutter and auricular fibrillation this blocking is due to pro-
longing the refractory period of the A-V node. That digi-
talis has a direct influence on the heart muscle finds support
in the flattening and final inversion of the T wave under its
influence, in the fact that releasing vagal control by atropin
in a digitalized heart in auricular fibrillation does not cause
the heart beat to approach the rapid rate that existed before
the administration of digitalis, also in the beneficial action
of digitalis in increasing the force and output of the ven-
tricle in the presence of cardiac failure, where the drug has
no influence upon the heart rate.

The influence of digitalis upon blood-pressure varies.   In
heart failure it may cause an abnormally low pressure to
rise, or an abnormally high pressure to fall. When digitalis
acts at all on the blood-pressure clinically it causes the lat-
ter to tend towards normal.   It is a vasomotor constrictor
regularly only in toxic doses. That it is a dangerous drug
to use in hypertension, in therapeutic doses, is unfounded.
Furthermore, there is no foundation for the belief that digi-
talis causes contraction of the coronary arteries, in any thera-
peutic amount.   Angina pectoris is a marked symptom of
heart failure and yet in many cases the administration of
digitalis does good.   Diuresis in heart disease following ad-
ministration of digitalis is wholly due to the improvement
in the general circulation; it has no direct influence upon the
kidney.   Gastrointestinal symptoms, especially nausea and
vomiting, usually occur when about four to six drams of
the tincture or its equivalent have been given. These symp-
toms may be present before digitalis is given; then they are
due to passive congestion of the stomach and liver, which
may be relieved by the cardiac stimulant. The appearance
of these symptoms after the exhibition of digitalis is evi-
dence that the drug has been absorbed to the point of tol-
erance, and ordinarily there is other evidence of its action
on the heart, as slowing of the rate.

Proof that the heart is being influenced by the digitalis
given is afforded by the improvement in the patient's con-
dition and by certain information shown by graphic methods.
The clinical betterment of the patient is shown in the relief

of dyspnea, cyanosis, cough, lessening of edema, reduction of heart rate, and ofttimes reduction in the size of a tender liver. Graphic methods show prolonged conduction, sinus arrhythmia, flattening or inversion of *T*, especially in Leads I and II, as comparatively early evidences of digitalization. The art of giving sufficient digitalis to affect the heart favorably and yet avoid the symptoms of intoxication is important. Where the condition is urgent it is often necessary to push the digitalis up to the first symptoms of intoxication, to be sure that the patient is taking enough of the drug, but with the appearance of the first symptoms, such as nausea, the dosage should be halved or the drug stopped entirely. The symptoms of digitalis poisoning are: First of all, nausea and vomiting—in some patients it provokes an early diarrhea—premature contractions, leading to bigeminy of the pulse, any degree of heart block, and marked degrees of sinus arrhythmia. The appearance of any one of these is evidence that the drug should be stopped.

Several methods for administering digitalis have been devised. Eggleston[121] has grouped them under the small dose method, the large dose method, and his own method according to body weight.

The Small Dose Method. This method requires from four to six days for digitalization. One to 4 grains of the powdered leaf, or 20 to 40 minims of the tincture, should be given four times daily and continued until digitalization is induced. This is the method ordinarily pursued and suffices except where the heart failure is severe and the patient must be brought under rapid digitalization.

The Large Dose Method. This method requires from one to two days for digitalization. During the first twenty-four hours, 6 to 7 grains of the powdered leaf or 1 dram of the tincture, is given every six hours for four doses. On the second day 3 grains of the leaf, or 30 minims of the tincture, is given every four hours during the day (four doses), and none at night. This dosage and interval are continued until full digitalization is secured.

With respect to the Eggleston method, there is no shorter route to a full understanding of this method than the de-

scription given by its author; therefore, we will quote him on the body-weight method:

"By this method full digitalization generally can be secured in from twelve to twenty-four hours, and incomplete digitalization of a valuable degree in six hours or less. The method depends on the establishment of an average total amount of digitalis which is required to produce full digitalization. The total amount is expressed in terms of the activity of the drug and the patient's body weight in pounds. The activity of the drug is determined by the Cat Method of Hatcher, the unit being the weight of dry drug, in milligrams, which is required to kill one kilogram of cat when injected slowly and continuously, intravenously. This amount of drug is termed the cat unit. The average total amount of digitalis required for oral administration to man is 0.15 of one cat unit per pound of body weight. Knowing the activity of the digitalis to be used, and having determined the patient's body weight, the total requirement for any given patient is calculated by one of the following formulas:

I. $\dfrac{\text{C.U.} \times 0.15 \times \text{W.}}{1000}$ = Grams of powdered leaf in total amount.

II. $\dfrac{\text{C.U.} \times 0.15 \times \text{W.}}{100}$ = Cubic centimeters of tincture in total.

III. $\dfrac{\text{C.U.}}{100} \times \text{W.}$ = Cubic centimeters of infusion in total.

"In these formulas C.U. is the number of milligrams in one cat unit and W. is the patient's body weight in pounds. The following example illustrates the use of these formulas: A patient weighs 150 pounds and the digitalis available has an activity of 100 milligrams to the cat unit. Applying Formula I for the powdered leaf, we have $100 \times 0.15 = 15$, $15 \times 150 = 2250$, $2250 \div 1000 = 2.25$ grams of leaf in total amount. Formula II gives $100 \times 0.15 = 15$, $15 \times 150 = 2250$, $2250 \div 100 = 22.25$ cubic centimeters of tincture in total amount.

Administration. "The validity of this average total amount has been confirmed by several observers, but it must be remembered that it is only an average figure and that the range of variation from the average, both above and below,

may be considerable in individual cases, in part due to variations in the absorbability of digitalis and in part to variations in the capacity for absorption in different patients. To allow for these variations and at the same time to secure very rapid digitalization, the total calculated amount is administered as follows: About one-half is given at the first dose; about one-fourth, or a little less, is given six hours later, and after another six hours about one-sixth to one-eighth of the total is given. Thereafter additional doses of about one-tenth of the total may be prescribed at six-hour intervals until the desired digitalization is secured. For example, if a patient's calculated requirement is 22.5 cubic centimeters of a given tincture, the first dose would be 11 cubic centimeters, the second 5 cubic centimeters, the third 3 cubic centimeters, and thereafter 2 cubic centimeters every six hours.

"The six-hour interval between doses allows time for complete absorption of each dose before the next is given and therefore permits the certain avoidance of serious intoxication. The method seems heroic but it is safe if the following *precautions* are observed: Administration should be stopped on the appearance of nausea or vomiting; if the heart rate falls below or to sixty per minute; or if any of the evidences of minor toxic action appear. This demands observation and questioning of the patients by the physician or by a skilled nurse before each succeeding dose after the first is given.

Modifications. "Special conditions demand more or less modification of this method. For example, if the patient can not be weighed, his weight must be estimated, or if there is edema or anasarca the normal weight must be approximated by making allowance for the weight of the fluid. The total requirement is then calculated as usual but only seventy-five per cent. of the calculated amount is to be administered in the first three doses. The usual one-tenth of the full calculated amount may then be given every six hours. When one can not secure a digitalis of known cat unit strength its activity may be taken as 100 milligrams per cat unit, this being the average for high grade digitalis. When the total requirement is calculated on this basis, only

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seventy-five per cent. of it should be administered in the first three doses.

"When the patient is known to have been taking digitalis during the ten days just preceding, he should be subjected to a careful examination, including the use of the polygraph or electrocardiograph if available, to determine whether or not there are any evidences of digitalis action. If there are no evidences of digitalis action and the patient's condition is urgent, the method may be followed without modification. If the condition is not urgent it is best to give only seventy-five per cent. of the total calculated requirement in the first three doses. If evidences of partial digitalization are present it is best not to administer more than one-half of the total calculated amount, divided equally among the first three doses. If the condition is urgent, however, one may administer seventy-five per cent. of the total calculated amount, preferably divided among the first three doses equally. In all these circumstances the usual one-tenth of the total amount may be prescribed after the first three doses, if needed.

"The body weight method is especially valuable in cases of severe heart failure in which the patient's urgent condition demands immediate relief; the employment of this method of administration in such cases generally yields such prompt results that resort to intravenous or intramuscular administration is seldom necessary."

Intravenous and Intramuscular Medication in Cardiac Disease. In cases of extremely sudden and pronounced cardiac failure, or when for any reason the patient can not or will not take medicine orally, then cardiac stimulants may be given intravenously or intramuscularly. It is to be emphasized that administration by these methods is an emergency measure, that most often the patient probably has already been taking cardiac drugs, and that skillful giving and skillful watching of the patient are necessary under these special conditions. Furthermore, it seems necessary to correct an impression existing in the minds of some, that digitalis given by hypodermic is not so apt to provoke vomiting. They overlook the fact that digitalis vomiting is largely a centric phenomenon. The most satisfactory drugs for hypodermic use are derived

from strophanthus. I have usually used amorphus strophanthin in normal salt solution in dosage of $\frac{1}{250}$ grain to $\frac{1}{125}$ grain, at two-hour intervals intravenously and four-hour intervals intramuscularly, and repeated for three or not more than four doses. These comparatively small doses are safer, for often we have evidence that the patient has been taking digitalis or have reasons to suspect it. Sometimes there is but little time to use graphic methods to determine this, but where the patient is known not to have had digitalis or its allies, then the need is probably greater and strophanthin may be given in doses as high as $\frac{1}{80}$ grain or $\frac{1}{60}$ grain, to be repeated not more than twice in twenty-four hours. Eggleston recommends ouabain, which is crystallized strophanthin—G of Thoms. He gives $\frac{1}{125}$ grain when the patient is known not to have received digitalis for ten days. The repetition may be in two hours, in intravenous, or four hours in intramuscular use. It is probably safer to halve the second dose. This writer says that no more than $\frac{1}{40}$ to $\frac{1}{30}$ of a grain of ouabain, or $\frac{1}{20}$ of a grain of amorphus strophanthin, should be given in twenty-four hours. Furthermore, that ouabain should not be used in greater concentrations than $\frac{1}{4000}$, nor strophanthin $\frac{1}{1000}$. In case of need tincture of digitalis, if freely diluted with freshly distilled water, can be used intravenously.

For intramuscular use one of the ampoules of digitalin Nativelle may be used. The fluid extract, because of its small bulk, may be used in the same manner if thrown deeply into the muscle and the area massaged for five minutes. All preparations of digitalis are too irritant for subcutaneous use. Again it should be emphasized that the intravenous and intramuscular administrations of the digitalis series is for emergencies, and emergencies only, and the same is true of the body weight method. *In the majority of cases the small dose method will suffice or, at most, the large dose method.* They not only will act but they are safer, generally, because it is difficult to have the patient under the skilled observation necessary when the more rapid methods of digitalization are undertaken.

The Continued Use of Digitalis. It is necessary to give digitalis to certain patients intermittently or continuously

for months or years, as referred to under the head of auricular fibrillation. Intelligent patients, under direction, soon learn to recognize incipient failure. A little increased breathlessness or cardiac distress, and especially in auricular fibrillation, increase in pulse rate, are their indications for digitalis. Since Pardee[122] has shown that the average individual will excrete or destroy about twenty minims of digitalis daily, it suggests a reason for the clinical fact that these patients usually need only from 15 to 30 minims of the tincture, or 1½ to 3 grains of the leaf, per day. Furthermore, the persistent action of the drug makes it possible to give this amount in a single dose daily, but if the patient prefers it, there is no objection to dividing it into two or three doses.

Because digitalis in overdose is undesirable many practitioners fail to get the best use of the remedy in those patients who need it more or less continuously. The physician must learn to recognize the patient who needs the drug continuously; teach him to recognize the symptoms which call for its administration and especially to count his pulse rate and to stop the drug when the rate falls to between seventy and sixty.

Other Drugs in Cardiac Failure. Tincture of strophanthus, in the past, has been our first thought when digitalis was not tolerated or gave unsatisfactory results. According to Eggleston strophanthus is one hundred times as active as digitalis and is poorly and irregularly absorbed, which may lead to accidental poisoning. Its action passes off in forty-eight hours or less after administration, whereas digitalis and digitoxin may persist in their action for two or three weeks. The active principles of strophanthus, ouabain and amorphus strophanthin were discussed under the head of intravenous and intramuscular medication. White[60] and his associates recently studied the effects of squill as compared with digitalis, especially in auricular fibrillation. Their conclusions are that squill does have a digitalis-like action if given in large doses—that is, from 2 to 4 dram doses of the tincture instead of the 15 minims as usually recommended. In these large doses the *T* wave was flattened or inverted, and blocking was induced just as in digitalis administration. Clinically some cases showed subjective improvement, also

there was a reduction of pulse rate, improved circulation and diuresis. Convallaria, in the form of the ordinary commercial tincture, in doses of 15 minims three times a day, must have little effect. I have had patients with functional nervous disorders who were convinced that they had heart disease and who had taken this dosage of convallaria for months at a time, with absolutely no influence on the heart, as far as one could find. Taught by the wisdom of my predecessors who had prescribed the drug, I have been guilty of using it under similar circumstances as a placebo. Whether a fresh preparation of the fluid extract would have the digitalis-like effect of prolonging conduction and flattening the T, and relieving subjective and objective symptoms of cardiac failure, I do not know. The patients who can not be handled with some form of digitalis and the alkaloids of strophanthus are comparatively few. Apocynum and camphor find little use in cardiac disease, spartein is probably harmful, strychnin is a useful general tonic but it is not a direct cardiac stimulant. Simple aromatic spirit of ammonia is fugacious but momentarily active as in fainting fits. The alkaloid caffein is to be preferred to citrate of caffein. It is a circulatory stimulant, but if used late in the day it is prone to aggravate the wakefulness from which these patients already suffer. It is more commonly thought of as a diuretic where edema exists in cardiac disease. As diuretics, theobromine sodium salicylate, in doses of 10 to 15 grains three or four times daily, or acet-sodiumtheocine, which is a salt of theophyllin with sodium acetate, in 5-grain doses three or four times a day, are much more satisfactory. Water should be taken rather freely especially with the latter as it has an irritant action on the stomach, though not so marked as plain theophyllin. As most diuretics fatigue the kidneys they should be given intermittently, that is, they should be administered for one or two days and then omitted for a like period.

Wakefulness and pain rapidly undermine the strength of a patient suffering from cardiac failure. Among the many lessons taught me by my friend and counsellor, the late Dr. John H. Musser, was the usefulness of morphia and codein in chronic cardiac failure, perhaps more often among

patients with degenerative myocarditis. Too often because
a patient with cardiac failure shows albumin and casts the
physician will not give the benefit of morphia or codein for
fear of provoking further kidney inactivity. Ofttimes the
urinary findings are simply due to passive congestion and
in any case the nocturnal dyspnea, wakefulness, pain and
restlessness do more harm to these patients than the nightly
giving of some form of opium for several days would ever
do. In the agonizing paroxysmal pains it is often the only
remedy that will relieve. Naturally where the sleeplessness
is not so great, a simple remedy should be tried first. Bro-
mides, barbital or veronal may suffice. Chloral hydrate is
one of the most satisfactory hypnotics, as the patient ordin-
arily awakens the following morning without any mental
depression. In small therapeutic doses there is no fear of
its depressant action upon the heart or circulation. Five
grains may be sufficient, fifteen grains in one night should
be a maximum. Syrup of ginger seems to disguise it about
as well as anything. In doses of one or two grains com-
bined with bromide three times daily, it has a beneficial effect
in patients with cardiovascular disease who are nervous,
restless, and have mild degrees of substernal distress.

The indication for the administration of digitalis in cardiac
patients is heart failure. The procedures to be adopted de-
pend upon the degree of cardiac incompetence, whether it is
mild, severe or extreme. In cardiac patients whatever the
lesion when breathlessness or pain are produced by the usual
daily activities, treatment is indicated. Ofttimes the mild
group may be treated while ambulant, if their physical ac-
tivities can be somewhat restricted. Digitalis by the small
dose method usually relieves such patients promptly. The
continued use of small doses will depend upon the comfort
of the patient following its withdrawal. Occasionally these
patients are nervous, apprehensive and suffer from broken
sleep, all of which may be relieved by bromides. They rarely
need opiates, but sometimes the milder hypnotic drugs re-
ferred to may be necessary.

In the *severer types* the dyspnea and distress will be more
marked. Orthopnea is frequently present and cardiac pain
may be more distressing. Naturally these patients should

be at complete rest in bed. These acute symptoms are ordinarily relieved by small doses of codein or morphine given from one to three days. Digitalis should be at once given by mouth, by the large dose method, and continued until the patient is better or a minor form of intoxication, as beginning nausea, occurs. Wakefulness and restlessness are common in this group of patients and if the narcotics referred to have not been given, then small doses of barbital, veronal, or chloral hydrate, may be tried first. In this group some edema may be present but its treatment will be considered in the next group, which is that of *extreme cardiac failure*.

This group needs a longer period in bed, a more prolonged convalescence, and supervision for a time even when the patients return to their usual activities. Whereas in groups one and two, a fortnight's rest may suffice to restore the heart entirely, these patients require a longer time in bed and should be kept at rest until all symptoms have disappeared and the heart seems to have regained its original functional capacity. If their symptoms are not too extreme the large dose method of administering digitalis may be used. Where necessary the Eggleston method may be selected and full digitalization may be expected in twenty-four hours or less. If the patient's condition appears critical, strophanthin or ouabain may be injected intramuscularly or intravenously, especially if the patient has taken no digitalis for from ten days to two weeks preceding. If a patient has been taking digitalis and the condition is urgent, the small doses of strophanthin or ouabain may be given with care. But it is understood that these are preliminary procedures meant to tide the heart over until the digitalis effect is secured. In these advanced cases of heart failure the patient usually suffers from one or more distressing symptoms. Dyspnea and orthopnea are often extreme, the patient is unable to lie down and needs a comfortable bed rest. This extreme breathlessness is often associated with cardiac dilatation, pulmonary engorgement, and hydrothorax. The last is more often right sided, especially in mitral disease, and tends to recur so that it may require repeated tapping. For the dyspnea especially at night, coupled with insomnia and restless-

ness, morphia and codein are invaluable. Atropin is better omitted, as it counteracts the action of digitalis on the heart through the vagus. Cough is common, hemoptysis rarer. They both arise from engorgement of the pulmonary vessels, and these patients are prone to bronchitis. The cough is relieved by the same remedies that relieve dyspnea, furthermore it gradually grows better after digitalis improves the circulation in the lungs. Hemoptysis occurs especially in mitral obstruction, and frequently if not too severe it may relieve the patient and ordinarily calls for no special treatment. Insomnia, bad dreams, nightmare, and broken sleep, are common in patients with even comparatively mild degrees of cardiac failure. For relief, Hoffman's anodyne, bromides in the early evening, chloral hydrate when settled for the night, paraldehyde, and finally morphia, have been advised. Edema may be marked in this group of patients, as retarded circulation diminishes the urinary output so that ascites and general anasarca are common. In such patients the Karrel diet is indicated. Some patients refuse this, but their fluid should be limited to eight hundred to one thousand cubic centimeters, and the other articles of diet should be dry and salt-free. Digitalis, by increasing the blood flow, may produce diuresis. Purging with calomel followed by a strong saline may be tried. Theobromine sodium salicylate, 10 to 15 grains, four times daily, or acet-sodiumtheocine, 5 grains, four times daily well diluted, will often cause profuse diuresis. Patients with marked gastrointestinal symptoms including nausea and vomiting are comparatively common. It is due to stasis in the splanchnic vessels, and the liver is frequently enlarged in these patients. In these patients remedies may have to be given temporarily hypodermically. Palpitation and precordial distress are common symptoms which the ice bag often relieves.

Failure with congestion predominates in the type of patient we have just spoken of. Then there is another group of cardiac failure associated with the various forms of cardiac arrhythmia. The treatment of these has been considered under the various headings of paroxysmal tachycardia, auricular flutter, auricular fibrillation, heart block, including the Adams-Stokes syndrome, and alternation. There is a definite

group of failure with cardiac pain usually referred to as angina pectoris. Patients subject to these attacks should carry a small vial of recently made tablets of nitroglycerin, $\frac{1}{100}$ to $\frac{1}{50}$ of a grain. As recommended by Janeway they should be freshly made every month, and when needed they should be dissolved under the tongue. They have the great advantage over amyl nitrite of not advertising the patient's misfortunes in public places. Where the attack is severe, morphia will be necessary. Aside from renal colic the conditions are rare where larger doses may be required. One-fourth of a grain may be tried, and it may be necessary to repeat it in a severe paroxysm. Occasionally amounts even up to a grain may have to be used, but it should be with careful oversight. These paroxysms of pain are an expression of one kind of cardiac failure. Since they are so frequently associated with hypertension—arteriosclerotic or renal—many physicians, as has already been said, hesitate to give digitalis under such conditions for fear of its vaso-constriction action. But attention has already been directed to the fact that it is only in toxic doses and not in therapeutic doses that this action is present. Therefore, there need be no fear of administering digitalis to these patients, many of whom are benefited by it, and by its more or less continued use in selected patients the attacks may lessen in number and severity.

Early cases of myocardial weakness, the neurotic heart, and the hearts of patients convalescent from acute infections, are greatly benefited by certain gymnastic exercises, by mechano-therapy, by respiratory gymnastics, by the Oertel Terrain Cure, by hydrotherapeutics alone or combined with exercise as practised at Nauheim and by the artificial Nauheim baths. Holst treats the whole subject in a chapter in Nelson's Loose Leaf Medicine.

HEART DISEASE AS A PUBLIC PROBLEM.

For some time the public aspect of heart disease occupied the minds of certain physicians in New York City. The outcome was the formation of the Association for the Prevention and Relief of Heart Disease, incorporated in 1915. The

objects of this association were: To gather information on heart disease; to develop and apply measures for the prevention of this disease; to supply occupations suitable for these patients; to establish special dispensary classes for such patients; to secure adequate care for cardiac convalescents; to urge permanent institutional care for totally incapacitated cardiac patients; and to encourage the establishment of similar associations in other cities. Their first studies showed that there was need of considering the heart disease problem in broad aspects. It was found that about five per cent. of our men called in the drafts in the world war were rejected because of organic diseases of the heart. In other words, among 5,000,000 men of military age, more than 200,000 were disqualified for service because of heart defects. About two per cent. of food handlers in New York were found on examination to have important heart disease. About two per cent. of life insurance applicants were rejected because of cardiac disease, and this in spite of the fact that people who have evident cardiac disease are not likely to ask for insurance.

In an examination of 250,000 school children in New York City, one and six-tenths per cent. showed heart defects, and at this ratio there should be some 20,000 school children in New York City with some form of cardiac disease. Roughly, any city may expect two per cent. of its school children will show some cardiac defect, and Emerson[123] concludes from his wide study of statistics that we may estimate that not more than two per cent. and not less than one per cent. of the total population at any time, need care and medical assistance because of heart disease. Hoffman, from mortality statistics, showed that one-eighth of deaths at all ages and one-fifth of deaths of persons of forty years of age and over were due to diseases of the heart.

Miss M. R. Strong, the former executive secretary of the Philadelphia Association for the Prevention and Relief of Heart Disease, collected the following statistics on the three great causes of death—tuberculosis, heart diseases, and cancer—for the last six years in Philadelphia:
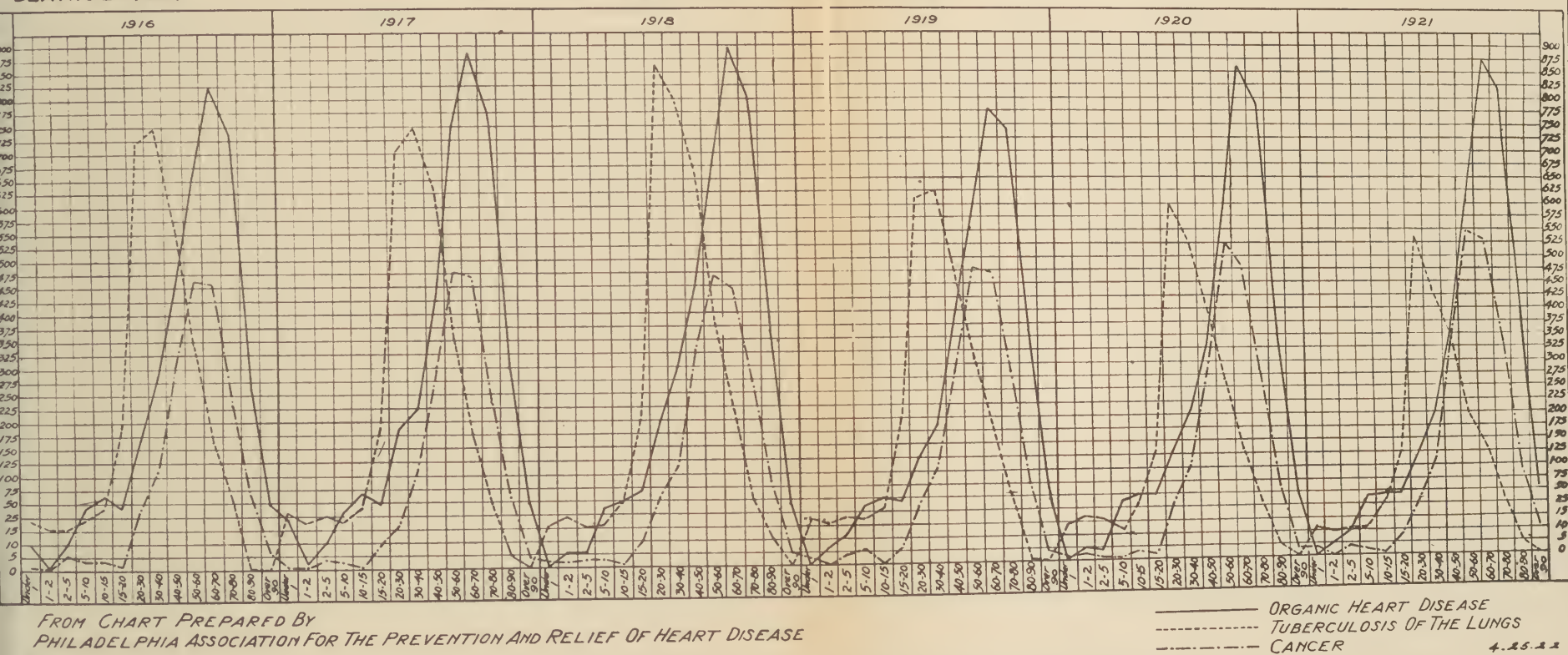
Fig. 51.

Year	Tuberculosis	Heart disease	Cancer
1916	2913	3441	1706
1917	3018	3545	1717
1918	3353	3769	1517
1919	2582	3123	1759
1920	2219	3275	1794
1921	1912	3409	2029

Miss Helen Heikes, the present secretary of the Phila-delphia Association for the Prevention and Relief of Heart Disease, collected the statistics and prepared the chart shown in Figure 51. Both show how heart diseases top these three diseases as the cause of death and especially well how deaths from tuberculosis have declined. Public interest in the heart disease problem in the next few years may lead to a similar decrease, it is hoped, in the death rates from cardiac disease.

The prevention of heart disease requires the coöperation of family physicians, of parents, of school authorities, and the public. A continual campaign of education is necessary to drive home a few truths such as the following: That there is a close relationship between rheumatic fever and heart disease in the young; that prolonged rest during convales-cence following rheumatic fever is absolutely necessary; that there is a close relationship existing between bad tonsils, adenoids, bad teeth, and infections affecting the heart; that systematic and repeated examinations of children's tonsils, adenoids, and teeth, and correction of abnormalities found, may guard against heart disease later; that the foundations of heart disease showing evidence in middle life are often laid in youth; and that every infectious disease is a potential cause of heart disease. Gonorrhea is a common cause, syph-ilis still more common, but its baleful influence upon the heart may not be in evidence until thirty years after the primary infection. Observation of these simple hygienic rules may spare many a healthy heart infection, and a dam-aged heart may be spared further infection.

The histories of children and adults with heart disease who return to the hospitals for readmission for repeated cardiac breakdowns, emphasized the recognized need for a prolonged

convalescence and led to the consideration of providing convalescent homes for the care of cardiac patients.

"Potential cardiacs" and those with the earliest evidence of "organic heart disease" are found in large numbers in all the clinics, and prolonged rest does much to avoid or alleviate further development of heart disease in these patients. The Burke Foundation alone cared for six thousand cardiacs in the first six years of its activity. Under the supervision of Dr. Frederic Brush a combination of rest, especially in the open, diet, and properly graded physical exercises, wrought wonders for these patients. Furthermore, the association by its own efforts and by stimulating other associations, listed occupations suitable for cardiac patients so that they may be self-sustaining at least in part, with less danger of cardiac failure arising from their daily work. The idea of establishing special clinics for those suffering from cardiac disease took root and developed, so that there are today in New York City thirty-four or more special cardiac clinics. The idea has spread so that almost all of the large cities and some of the smaller cities have cardiac clinics in operation and their number is constantly increasing. The New York association found the schools a fertile field for prevention, and they have also tried out the value of segregating school children with cardiac disease in special classes or special schools with good results.

Thus it will be seen that the public problem of heart disease is akin to that of tuberculosis. Any person, lay or medical, who will compare the outlook for the tuberculosis patient thirty years ago with that of today will easily find reason for agitating the heart disease problem. The convalescent cardiac especially has usually not received the care he deserves. When in early convalescence from an attack of cardiac breakdown he was up and around the hospital ward, it seemed unfair that he should occupy a bed which a patient with pneumonia or some other acute disease needed. Heretofore there have not been sufficient convalescent beds for patients of this type. When hospital authorities awaken to the fact that satisfactory convalescent beds can be supported for about half the cost of hospital beds we shall expect to see more places available for these patients. That there is

work sufficient for both medical and lay members in this effort is shown by the program laid out by the New York Association for the Prevention and Relief of Heart Disease in their first annual report. The tasks which they have set themselves were:

I. Relief.

1. Standardization and improvement of cardiac clinics.
       More facilities for the removal of foci of infection.
       Development of greater social service facilities.
2. Encouragement of closer co-operation between the general hospital, the general medical clinics, convalescent homes, and occupational bureaus for cardiacs.
3. More facilities for the cardiac convalescence of boys and young men.
4. More facilities for the convalescence care of colored cardiacs.
5. Tabulations of results of relief measures.
6. Development of facilities for vocational guidance and occupational placement of cardiacs.

II. Research.

1. Value of the segregation of school children with heart disease in special classes.
2. Comprehensive study of the present provision and need of extension of facilities for the care of advanced cardiacs.
3. Studies of the causes of heart disease with a view to prevention:
       (a) Infections, syphilis, rheumatism, etc.
       (b) Strains, occupations and habits.
4. Studies on the most useful classification of the degree of cardiac impairment.
5. Studies on the results of various forms of treatment, exercise, occupations, etc.
6. More exact studies of the economic aspects of heart disease.
7. Study of feasibility and methods for standardization of commercial preparations of digitalis.

III. Educational.

1. Dissemination of a knowledge of methods of prevention and of the facilities for the relief of cardiacs.
2. Collection of materials for exhibits, such as charts, lantern slides, moving pictures, etc.
3. Extension of movement to other parts of the country.

The experience of the New York Association of Cardiac Clinics has caused it to adopt the following terminology, which is in general use in the case of dispensary patients, and some such classification is necessary so that workers

in one clinic may understand those of another. It also serves as a common basis for selecting convalescent patients for admission to convalescent homes.

FUNCTIONAL CLASSIFICATION OF CARDIACS.

Organic Heart Diseases.

CLASS   I. Patients who are able to carry on their full habitual activity.

CLASS   II. Patients able to carry on diminished physical activity.
        A. Slightly decreased.
        B. Greatly decreased.

CLASS III. Patients who are able to carry on no physical activity

Possible Heart Disease.

CLASS IV. Patients who have abnormal physical signs in the heart, but in whom the general picture, or the character of the physical signs leads us to believe that they do not originate from cardiac disease.

Potential Heart Disease.

CLASS V. Patients who do not have any suggestion of cardiac disease, but are suffering from an infectious condition which may be accompanied by such disease: *e.g.*, rheumatic fever, tonsillitis, chorea, syphilis, etc.

These clinics also have arrived at the following tentative rules for selecting cardiac patients for convalescent care after their hospital treatment:

    I. Convalescent homes should accept patients with heart disease only after they have been examined at a cardiac clinic.

   II. Patients proposed should be held to the following types:
        1. Those needing convalescence for other conditions than heart failure, but who incidentally may have heart defects (under Class 1 of the classification of cardiac patients, as adopted by the Association).
        2. Convalescents from acute heart failure, who have been out of bed for some time, in the hospitals or at home, and who show no dyspnea after moderate exercise. (Classes II and III of the classification of cardiac patients, as adopted by the Association.)
        3. Patients who are not convalescent from acute heart failure, but who show signs of heart and general fatigue while under observation at the clinic, and who need shorter preventive stay. (Class III of the classification of cardiac patients as adopted by the Association.)
        4. Younger persons yield best results and are given preference. (Note—Too few persons are sent of the types indicated under 1 and 3, above.)

III. The following types of patients are not considered suitable for convalescent treatment:

    1. Convalescent from acute rheumatic fever, not to be sent until joint symptoms have been absent for three weeks.

    2. Cases that show lung congestion, or a tendency to bronchitis or asthma.

    3. Persons with marked renal complications.

    4. Those mentally, nervously or otherwise unpromising for the essential active co-operation and long stay. This would include patients who are likely to develop homesickness, or who might be unable to adapt themselves to a régime.

IV. The following co-operation shall be given by the submitting agencies:

    1. Help to lessen the strain and fatigue of the admission day (transportation to admission office, etc.).

    2. Hospitals should take back patients at the beginning of a relapse that may develop while at home.

    3. Social service should follow up cases promptly on their return to the city, to prevent relapse which frequently occurs at the time; placing the patient in suitable occupation as soon as possible, to avoid the bad mental effect of being unemployed.

Experience had taught us that tuberculosis and diabetes could be better handled in special classes or clinics and the same has been found true of heart disease in the various centers where it has been tried out. The special heart clinic should be an aid to the general medical clinic. If the physician in charge of the general medical clinic prefers to keep oversight over his patients, he should at least be glad to have them examined by special methods and the cardiac clinic should furnish him with such reports. The director of the cardiac clinic can extend the usefulness of the work if he invites the practitioners in the neighborhood, a few at a time, to visit his clinic and become acquainted with the methods. The general practitioner, if alert, will be stimulated to take more interest in his cardiac patients, in the heart problem, and may make use of the clinic for purposes of consultation. The point is in this era of transition, workers in this subject must show their colleagues, both inside and outside the hospital, that their interest is in securing a better understanding of heart disease, and in stimulating physicians in general and the public to an interest in the subject. The result will be that the cardiac patient will receive that public justice

finally afforded the tuberculous patient, which is also due the cardiac sufferer.

Those interested in this subject should read Dr. Haven Emerson's Shattuck Lecture on "Prevention of Heart Disease—A New Practical Problem," also the First Annual Report of the New York Association for the Prevention and Relief of Heart Disease.

I wish to express my indebtedness to the Trustees of the Presbyterian Hospital for enabling us to establish one of the early heart stations; to my colleagues of the Staff who have furnished many patients for study; to Dr. William D. Stroud for a critical reading of the section on the myocardium and for constructive suggestions concerning it; to Dr. John Eiman for his interest in the pathologic aspects of heart disease; to Dr. Charles W. Lueders for his polygraphic work; to Drs. William Hewson and O. K. Reed for their active coöperation in the work of the station; and to Dr. C. Lincoln Furbush, Director of Public Health, for his active and sympathetic interest in the Philadelphia Association for the Prevention and Relief of Heart Disease.

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Chronic Disease of the Arteries

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Chronic Disease of the Arteries.

INTRODUCTION.

THE influence of age in the production of certain disease conditions is a well recognized principle of general pathology. Nowhere is this relationship between age and disease more apparent than in diseases of the arteries. It may be stated with assurance that in all individuals from the age of thirty-five years, when growth is complete, onward, degenerative changes are taking place in the vascular tree. Indeed, so frequent are these changes that they may be looked upon as one of the physiological processes of advancing age. The rate at which these changes take place varies. In some individuals degenerative processes in the blood-vessels proceed with great rapidity, producing conspicuous changes in other organs, and giving rise to marked functional impairment and obvious symptoms. In others the process is so gradual and benign, that its development is unrecognized and the individual may attain old age without manifesting noteworthy symptoms of arterial degeneration.

That arterial degeneration should be the inevitable accompaniment of advancing years is not surprising when one recalls the oft repeated statement that of all the organs in the body, it is the blood-vessels alone that never enjoy the opportunity for rest. Osler has graphically pointed out this when he says that not only does the blood constantly pass through the arteries at a speed of ten inches per second, but the walls of the aorta and great vessels are being subjected to a distending force of about twenty-five pounds to the square inch, sixty to eighty times a minute, or 80,000 to 100,000 times in each twenty-four hours.

The frequency of arterial disease, the widespread changes which it produces in other organs, and the serious complications that so often supervene in the course of such disease, make the subject one of unusual importance to every prac-

titioner. In addition, there is ample statistical evidence
pointing to the fact that diseases of the blood-vessels are
definitely on the increase among the men and women who
live and work in the cities of Europe and America, and
nowhere is this increase more marked than in the United
States. Furthermore, it is incumbent upon clinicians to ac-
quire a thorough understanding of chronic arterial disease,
because of the necessity that exists for its early recognition,
since in this way only can we hope to check its progress
and to prevent its dire complications. In this connection
attention should be drawn to the fact that although the ob-
trusive evidences of arterial degeneration frequently are not
manifest until late in life, the disease has its beginning at
a much earlier period. Therefore, it is during middle age
or earlier, that the first manifestations of arterial degenera-
tion should be sought. There must be developed in phy-
sicians more general appreciation of the fact that chronic
degenerative lesions of the arteries are by no means limited
to the aged and that, on the contrary, in at least certain of
its forms, arterial disease is essentially a process of middle
age.

Considerable confusion has arisen because numerous stu-
dents of the subject of arterial degeneration have seen fit
to designate the process by a variety of names. Lobstein,
who along with other observers, was impressed by the fre-
quent occurrence of hardening of the vessel walls, was the
first to apply the term "arteriosclerosis" to this condition.
Huchard, with his attention apparently focused chiefly upon
certain degenerative lesions in the great vessels characterized
by softening, advocated the name "atherosis." Gull and Sut-
ton, emphasizing the rôle that the arterioles and capillaries
play in the process, introduced the term "arterio-capillary
fibrosis." "Chronic arteritis," "atheroma," and "endarteritis
deformans" are some of the other terms that have frequently
been used to describe the process. It is doubtless true that
none of the terms thus far suggested are without criticism,
since most of them are descriptive of some one phase rather
than of the condition as a whole. Under present circum-
stances, however, it would seem that the best plan is to fol-
low the suggestion of Adami, and adopt the term "general

arteriosclerosis" to signify this diffuse chronic disease of the arteries.

Much of the discussion that has served to confuse the subject of arteriosclerosis, has grown out of the fact that it has not been sufficiently appreciated that the condition is not a clinical entity—not a disease *sui generis*—but rather a diffuse degenerative and inflammatory process of blood-vessels. A condition which is not the result of a single causative factor but which has a multiple etiology; a process which exhibits not only a variety of pathological changes depending upon the size of the vessels involved, but which is also capable of varied clinical manifestations, not only in different people but in the same individual at different periods. If at the outset such a conception is adopted, it materially lessens the difficulty attendant upon a consideration of the classification, pathology and symptomatology of arteriosclerosis.

ETIOLOGY OF GENERAL ARTERIOSCLEROSIS.

In spite of the fact that arteriosclerosis has been recognized since the days of Morgagni and much painstaking effort has been expended in an attempt to discover its mode of production, we are today far from a clear understanding of the cause of this process. As has already been pointed out, no one single cause can be held responsible for the condition. In some cases one and in some another factor seems the dominant influence in producing the degenerative changes in the arterial tree. As a rule there is difficulty in fixing responsibility on any single factor because of the co-existence of several possible causes. Among the varied conditions that have been held accountable for arteriosclerotic changes, there are some that must be regarded as predisposing or contributing, while others again may be looked upon as exciting.

Heredity. Heredity must be accorded a place among the contributing factors. In spite of the present day tendency to attribute a minor etiological rôle to heredity in the production of chronic visceral disease, it is undeniably true that in certain cases of arteriosclerosis heredity is an important determining factor. This has been repeatedly insisted upon

by Sir William Osler. The different qualities of "vital rubber" that go into the makeup of our vascular tubing is a now well-worn simile for which we are largely indebted to him. If some hereditary influence is not at work, it is difficult to explain the early development of arteriosclerosis in certain individuals and the consistent occurrence of arterial changes in successive generations of certain families.

Examples where this occurs are not hard to find. Brill and Libman[1] reported a girl, aged fourteen, who died of hemiplegia. Autopsy showed general arteriosclerosis and chronic contracted kidneys. The family of this girl showed a marked tendency to arteriosclerosis. In her case there seems to have been no factor such as syphilis or the acute infections, and all other etiological factors appear to have been excluded. The writer can recall one family in which both parents died of cerebral hemorrhage in their early sixties, and of their four children, all of whom developed evidences of arteriosclerosis associated with hypertension, between their forty-fifth and fiftieth years, two who are in the sixth decade of life have already suffered cerebral hemorrhages, whereas the two who are younger have not as yet been overtaken by any vascular catastrophe. In another family the great-grandfather, grandfather, father and several paternal uncles all succumbed to some accident of arteriosclerosis in their early fifties, and their only male descendant, today in his late thirties, has a blood-pressure considerably higher than is normal for his age. Similar instances of this kind might be multiplied were it necessary to furnish additional evidence in support of the long recognized familial tendency to vascular degeneration.

The explanation of this hereditary tendency is still obscure. By some it has been suggested that certain individuals are born with vascular tissue that is of poor quality, illy suited to withstand the wear and tear of life. On the other hand, environment may be in reality the determining factor; that is, the same mode of life and the same pernicious habits of eating, drinking and working, that induced arteriosclerosis in the parents, in turn tend to bring about a similar condition in their offspring. In some instances syphilis is certainly responsible for hereditary arteriosclerosis. This is

particularly true of those instances in which marked arterio-
sclerotic changes and even cerebral hemorrhages have been
reported in young children. To such cases, as Warfield[2] sug-
gests, the term "congenital arteriosclerosis" might properly
be applied. However, many instances of arteriosclerosis are
met with in which the condition is present in several mem-
bers of the same family, often developing at an early age,
in which no evidence of syphilis can be found. In such in-
stances the inherited proclivity to the disease rests upon
another and a different basis.

The probable rôle that heredity plays in the development
of arteriosclerosis is of especial interest from the standpoint
of the disease in middle life. Although vascular degenera-
tion may be looked upon as almost a physiological process
in the aged, it cannot be so regarded when it is met with
in younger people. Therefore, when well marked arterio-
sclerosis is found in early middle life, in the absence of other
etiological factors, heredity cannot be overlooked as a pos-
sible predisposing cause.

Age. As has already been pointed out, arteriosclerosis in
some form is the inevitable accompaniment of advancing
years. As an involutionary process it may be looked upon
as part of the normal physiology of old age. Nevertheless,
it is a grave error to limit one's conception of arteriosclerosis
to the condition as it presents itself in old people. It is true
that arteriosclerotic changes are rare before middle life, and
the condition usually develops after the fortieth year, but
no age period is exempt. In W. H. Smith's[3] series of four
hundred and forty-two cases of arteriosclerosis that came to
autopsy at the Massachusetts General Hospital between 1898
and 1908, approximately one-fifth of the cases occurred be-
tween forty and fifty years, and two-thirds between fifty and
sixty years of age. Recent statistical evidence seems to in-
dicate that as the result of the strain of modern life, arterio-
sclerotic changes tend to occur more prematurely than
formerly.

The age at which arteriosclerotic changes become mani-
fest depends upon the exciting cause of the condition and
the particular type of arteriosclerosis that develops. The
involutionary form of arteriosclerosis, the outcome of ad-

vancing years, rarely makes its appearance before the age
of sixty. On the other hand, the type that is so conspicuous
during middle age, the form associated with high blood-
pressure, develops as a rule after the age of forty-five and
before sixty. Exceptions to such arbitrary age limits are many.
For example, the writer has under his care a young man
who, at the age of twenty-five years, exhibited well marked
vascular changes and a systolic blood-pressure of two hun-
dred and ten, with a diastolic of one hundred and forty.
Careful search failed to reveal the presence of an underlying
infection or nephritis. Arteriosclerosis secondary to infec-
tions or to nephritis, may develop at any age, and the ma-
jority of the cases of arterial change observed in young
children fall in this category. There was recently admitted
to the writer's hospital service, a child aged twelve years,
whose thickened peripheral vessels and extraordinary hyper-
tension (systolic two hundred and forty, diastolic one hun-
dred and sixty) were the result of a chronic nephritis sec-
ondary to streptococcus infection of the throat.

The literature is full of well-authenticated instances of
juvenile arteriosclerosis. O. Müller[4] reports among other
cases that of a child, aged five years, in whom the aorta was
atheromatous. Oppenheimer[5] reported arteriosclerosis in
two boys, aged nine and ten years respectively, both cases
being of infectious origin, in one of which spontaneous rup-
ture of the aorta occurred. The entire subject of juvenile
arteriosclerosis has been carefully reviewed in an excellent
paper by Fremont-Smith,[6] who collected one hundred and
forty-four cases. The frequency of undoubted arteriosclerotic
changes in young people is indicated by von Romberg,[7] who
stated that in 1477 autopsies on all ages, he found two in-
stances of arteriosclerosis between the ages of two and four-
teen years, and five and eighty-eight-hundredths per cent.
between the ages of fifteen and nineteen years. Seitz[8] noted
that in one hundred and forty-eight cadavers there were ten
instances of undoubted arteriosclerosis in individuals aged
from ten to twenty-nine years. He quotes Waldstein as
having observed eight cases between seventeen and twenty
years of age in one hundred and two autopsies. There is no
intention of here entering into the interesting problem of

arteriosclerosis in the young; the subject has been introduced in order to emphasize the fact that although arteriosclerosis in the majority of instances is a disease of middle and later life, it is in no sense peculiar to any age period.

Sex. It has been generally conceded that sex must be regarded as a contributing factor in arteriosclerosis. Here again, however, the relationship depends upon where the statistics studied have been gathered, as well as the type of arteriosclerosis under consideration. In W. H. Smith's[3] series, collected from the Massachusetts General Hospital, arteriosclerosis was three times as common in the male as in the female. This ratio is in exact accord with the statistics given by Allbrecht. In the Philadelphia General Hospital, an institution in which many chronic cases are cared for, the ratio of males to females is not so great and approaches nearer two to one. In the writer's experience, however, contrary to the usual statistics, in private practice arteriosclerosis is encountered with equal frequency in men and women.

The distribution as to sex also varies somewhat with the type of arteriosclerosis studies. Personal observations would indicate that in general hospital practice, in proportion to the number of admissions, the senile form of arteriosclerosis is quite as commonly met with in women as in men. On the other hand, the form of arteriosclerosis associated with hypertension is decidedly more frequent in men. In a series of cases showing high pressure from various causes collected from the writer's private records, the converse was true. Primary hypertension and hypertension with arteriosclerosis were more common in women than in men. The frequent occurrence of primary hypertension of menopausal origin in this series apparently accounted for this finding.

Statistical data in general, if all forms of arteriosclerosis are considered, definitely indicate that men are more liable to degenerative arterial change than women. The usual explanation offered for this fact is probably the correct one—namely, that men are more exposed to the conditions that tend to produce vascular disease, such as physical overwork, business and professional cares and worries, infections (notably syphilis), and overindulgence in food, alcohol and to-

bacco. On the other hand, when women are subjected to the same influences as men, they develop arteriosclerosis apparently with equal ease.

Race. It is difficult to obtain accurate and unbiased data on the incidence of arteriosclerosis in different races. It is generally conceded that in the United States the condition is more frequent than in European countries, that it is on the increase, and occurs earlier. However, in the Massachusetts General Hospital series,[3] arteriosclerosis was found in about equal frequency in Americans and foreigners. In the same series it occurred no earlier in the negro than in the whites. On the other hand, Warfield[2] states that arteriosclerosis is not only more frequent in the American negro, but that the onset is much earlier in the colored than in the white races. This fact he attributes largely to the prevalence of syphilis and hard manual labor. According to Camac's[9] observations the colored race is affected with arteriosclerosis four times more frequently than the white. The Jews are said to be especially prone to the senile form of arteriosclerosis. In the tropics it has been observed that although blood-pressures are as a rule low, senile changes in general come early and as a consequence the involutionary form of arteriosclerosis is met with at an earlier age than in cooler countries. On the whole, it seems questionable whether race and nationality in themselves have any definite bearing on the development of arteriosclerosis.

Thus far only those factors which possibly contribute to the production of arteriosclerosis have been discussed. The conditions which actually cause arterial degeneration have yet to be considered and may be grouped as follows:

1. Occupations and habits of life.
2. Muscular overwork.
3. Infections.
4. Intoxications.
5. Overeating.
6. Special conditions that bring about a persistently high blood-pressure.

Occupations. It is a trite saying, though none the less true, that the exigencies and strains of modern business, professional and social life are in no small measure respon-

sible for the increasing occurrence of arteriosclerosis. This is borne out by the distressing frequency with which the condition, especially when associated with high tension, is met with among middle-aged business and professional men and women. It appears to be much more frequent among the brain workers of cities than in those who live in rural districts, but this difference may be more apparent than real, due to the fact that medical advice is more frequently sought and diagnostic facilities are better as a rule in the larger centers of population than elsewhere. Mental effort, even when prolonged and arduous in itself, does not seem to be so much a determining factor as the worry and constant nervous tension that too frequently is associated with such activity. The arteriosclerotic changes peculiar to middle life are particularly prone to develop in those who are constantly laboring under the strain and bearing the responsibilities attendant upon the management of large business and financial interests. The terrific pace of modern business life leaves its mark upon the vascular apparatus even when it is unaccompanied by excessive social activities and indiscrete habits of eating, drinking and smoking. There is a tendency on the part of many to "burn the candle at both ends." After days of "race and rack and strain," the nights, too, are given over to long hours of work or play instead of to proper rest. Much hard work can be done by day if an adequate amount of sleep is obtained at night, but when even the human machine is kept constantly going without sufficient opportunity for repairs, something must give way and too often it is the vascular apparatus that first shows the evidences of such wear and tear. The same may be said of those actively engaged in the professions, for arteriosclerosis is no discriminator of persons and attacks as often the lawyer and the physician as it does the man of business. Indeed, it is generally conceded that physicians are especially prone to suffer from arterial disease or some of its consequences. Whether it be in business or in the professions, the rewards and enjoyment of well earned success are too often marred by the advent of premature arteriosclerotic changes.

Although arteriosclerosis, the result of the strain and tension of modern business life, is obviously much more com-

mon in men than in women, the latter are by no means exempt. The writer's personal experience would indicate that the high pressure type of arteriosclerosis so often found in men of large affairs, is by no means infrequent in women. As is the case with men, it makes its appearance during middle age and is especially prone to develop in women of the well-to-do class who frequently not only eat too much and exercise too little, but live at high speed by reason of excessive social activities and a multiplicity of outside interests.

Muscular Overwork. In spite of the frequency with which arteriosclerosis is found in those whose pursuits are associated with mental strain and worry, it must not be thought that the condition is limited to this class of workers. It has long been known that those whose occupation entails constant physical overstrain are frequently sufferers from arteriosclerotic change. There is ample evidence to indicate that even when other factors, such as improper diet, alcohol, and various infections—notably syphilis—have been excluded, prolonged muscular overexertion must be held accountable for the development of arteriosclerosis. Arteriosclerosis is particularly conspicuous among certain classes of laborers, especially stevedores, seamen, stokers, freight handlers, and truck and ice-wagon drivers. The disease is apt to develop in early middle life in those who follow such laborious occupations, and although it is frequently accompanied by a high blood-pressure, it is not unusual to find in individuals of this class, the senile type of the disease developing prematurely. An increased incidence of arteriosclerosis has been noted among coal miners, iron workers, and blacksmiths. The condition is by no means limited to those who are industrial or city workers, as arteriosclerosis has been reported as a frequent occurrence among European peasants and farm laborers.

In those who develop arteriosclerosis chiefly as the result of manual labor, it is said that the sclerosis is largely confined to the vessels of the limbs, and out of 1384 young laborers, Friederich[10] observed arteriosclerosis in the limbs of 1000. Baumler[11] has emphasized the frequency of arteriosclerosis in the arms of laborers, and has called attention to

the fact that the vascular changes are greater in the arm that is the more used. Others have made similar observations on the asymmetrical development of arteriosclerosis in the extremities. In laborers whose work entails heavy lifting, the aorta and great vessels suffer equally with those of the limbs. These arteriosclerotic changes, the result of prolonged muscular overexertion, in some instances appear to be the result of frequently repeated elevation in the general blood-pressure. In other instances, however, local rises in pressure would seem to be responsible for the arterial damage. As has been suggested, prolonged muscular overwork *per se*, undoubtedly can produce arteriosclerosis, but it is more than likely that in the majority of instances some toxic or infectious agent serves as an important contributing etiological agent. Arteriosclerosis from heavy labor is undoubtedly much more common in men than in women, but it is by no means rare to find well marked arteriosclerotic changes in the limbs of women who toil laboriously.

In this connection it is of importance to consider the effect of excessive athletics on the production of arteriosclerosis. In otherwise healthy young men, who take part in school and college athletics, arteriosclerotic changes are rarely found, but the personal experience of the writer would indicate that those who have indulged in certain forms of violent muscular exercise during their school and college careers, especially in such forms of exercise as rowing, long distance running, distance swimming and weight lifting, are especially liable to the development of arteriosclerotic changes during early middle life. More work should be done along these lines, and accurate information is needed as to the ultimate effects on the circulation of the more violent forms of college athletics.

Infections. In recent years, as our knowledge of infectious diseases has increased, it has become more and more apparent that infection stands in important causal relationship to arteriosclerosis. Of all the infections the most important one, so far as the etiology of arteriosclerosis is concerned, is syphilis.

The syphilitic nature of certain forms of vascular disease has been recognized for many years. Lancisi, as far back as 1728, pointed out a relationship between aneurism and syph-

ilis. In the last quarter of the nineteenth century this relationship was firmly established by F. H. Welch,[12] who also described a syphilitic aortitis. Ten years later (1885) Heller[13] and his co-workers clearly distinguished syphilitic lesions of the aorta from other forms of arteriosclerosis, and described what is now generally recognized as luetic mezoaortitis. Confirmation of the well established belief that syphilis played an important rôle in the production of arteriosclerosis came after the demonstration by Schaudinn and Hoffman, in 1905, that the *Spirocheta pallida* was the specific cause of syphilis, and the development of the Wassermann test about a year later. Since that time numerous bacteriological, serological and clinical observations, carried out by a host of observers, including Mönckeberg,[14] Citron,[15] Collins and Sachs,[16] Klotz,[17] Wright, J. H., and Richardson,[18] Brenda,[19] Longcope, W. T.,[20] and Warthin,[21] have proved the causative rôle played by syphilis in the production of arteriosclerosis and allied vascular lesions. In many instances the spirocheta has been demonstrated in the lesion of the vessel walls, not only of the aorta, but also of the small peripheral and visceral vessels. The changes set up in the vessel walls by syphilis are distinctive, and their pathological picture is different from other lesions of arteriosclerosis. The rôle of syphilis in relation to diseases of the cardiovascular system has been carefully reviewed by R. M. Pearce.[22]

The importance of syphilis as a causative agent in arteriosclerosis is particularly evident in young and middle aged individuals. Indeed at this time of life it constitutes the most important infectious cause of vascular degeneration. In both hospital and private practice, syphilis must never be overlooked as a cause of arterial lesions in young and middle aged men. In the writer's hospital experience syphilis is the commonest cause of arteriosclerosis in men between the ages of thirty-five and fifty. In a series of private patients, however, lues did not play so conspicuous a rôle as an etiologic factor. Although the aorta and its branches suffer more often than do other vessels from the effects of syphilis, the smaller vessels also suffer with great frequency, and it is common to find lesions the result of syphilitic involvement of the cerebral, visceral and peripheral arteries.

Although perhaps the most important, syphilis is by no means the only infectious disease responsible for arteriosclerosis. Changes affecting one or more of the arterial coats have been described in acute articular rheumatism, diphtheria, scarlet fever, measles, pneumonia, influenza and typhoid fever.

Klotz[23] demonstrated that rheumatism may lead to small areas of medial fibrosis. He also found medial changes in scarlet fever. Arterial changes were described by Symnitzky,[24] following pneumonia, typhoid fever, tuberculosis, scarlet fever and other acute infectious conditions. The effects of these infectious fevers on the vascular system is clearly indicated by the careful work of Wiesel.[25] This author found eighty cases of beginning arteriosclerosis in three hundred children, dead of acute infectious diseases, who came to autopsy. The changes observed were found in both the large central and smaller peripheral vessels. In some instances macroscopic changes were noted, but, invariably striking microscopic evidences of arterial involvement could be found. Wiesel observed these degenerative changes in twenty cases of diphtheria, twenty of scarlet fever, and in forty of other acute infections including measles, pneumonia, influenza, pyemia, typhoid fever, cerebrospinal meningitis, and acute suppurative osteomyelitis and otitis. Thayer and Bush,[26] in a study of the relation of acute infections to arteriosclerosis, based upon the records of palpability of the radial arteries in 3894 consecutive patients admitted to the wards of the Johns Hopkins Hospital, found that the percentage of palpable radial arteries is higher among those cases presenting a history of severe infectious disease than it is among those in which this history is absent, or among those from whom no history of any causal factor could be obtained. They further concluded that rheumatism was the acute infection after which the percentage of palpable vessels was highest, and that next to rheumatism comes typhoid fever. In this connection it is interesting to recall that as long ago as 1885, Landouzy and Siredey[27] called attention to the frequent vascular complications that occurred after acute articular rheumatism and typhoid fever.

Arteriosclerotic changes, the result of typhoid fever, have been subject to frequent investigation. Thayer and Bush[26] record the fact that out of ninety-five autopsies on patients dying of typhoid fever, the condition of the aorta was observed in fifty-two. In thirty of these sclerotic changes were noted in the aorta. In sixty-two cases the condition of the coronary arteries was noted, and in nineteen definite sclerotic changes were observed. The effect of typhoid fever in the production of arteriosclerosis is shown by the well-known work of Thayer,[28] who studied one hundred and eighty-three individuals with typhoid fever in the Johns Hopkins Hospital. Over fifty per cent. of the cases above twenty years of age showed palpable radial arteries. He also found the average systolic blood-pressure in these old typhoids appreciably higher than in control observations upon healthy individuals. Thayer further observed that the radial arteries in the old typhoids were palpable in a proportion nearly three times as great as that found in control observations upon supposedly healthy individuals who had never had this disease.

There seems to be sufficient evidence to justify the belief that infectious fevers, in some instances at least, play a part in the causation of arteriosclerosis. It is difficult to say whether the changes observed during and after the acute infections are of a permanent nature. It is highly probable that in many instances regeneration occurs, so that the vascular damage due to an acute infection ultimately disappears. It is likely, however, that typhoid fever and other acute infections not only produce immediate changes in the vessel walls, but also exercise some influence upon the vascular coats which render them particularly liable to arteriosclerosis when subjected to later strain and other toxic influences.

Of late years, as the question of focal infection has obtained great importance, the effect of local foci of infection upon arterial disease has been considered. Chronic intoxication resulting from pyogenic foci about the teeth, tonsils, accessory sinuses or even the gall-bladder, appendix, prostate, urethra and pelvic organs, may be a causative or at least a contributory factor in the production of arterial degeneration in many instances. Along with others, the writer has observed cases

in which the removal of abscessed teeth or the clearing up of an infected focus about the gall-bladder or prostate, has been promptly followed by the lowering of a previously persistent arterial hypertension, which if allowed to continue would have led to, or been associated with, arteriosclerotic changes. In such cases it seems fair to assume that the focus of chronic infection was responsible for the vascular changes that were developing. The matter is of considerable practical importance, and strongly suggests that particularly in early arteriosclerotic changes, with or without hypertension, foci of infection should be carefully searched for and, if possible, eradicated.

Intoxications. A varied and heterogeneous group of toxins has been held responsible for the development of arteriosclerosis. These toxic causes may be grouped under the exogenous and endogenous poisons.

Among the exogenous toxic causes of arteriosclerosis popular belief and tradition readily accord first place to alcohol. An unbiased and critical review, however, of the clinical and scientific facts in regard to this drug, make it evident that there is ample reason to doubt whether alcohol is really such an important factor in the production of arteriosclerosis as is generally believed. In this connection Cabot's[29] observations are significant. He found that in only six per cent. of two hundred and eighty-three cases of chronic and excessive alcoholism, under the age of fifty years, was there any evidence of arteriosclerosis. Of six hundred and fifty-six autopsy cases of arteriosclerosis, only ninety-five were under the age of fifty. Of these ninety-five cases under fifty in which arteriosclerosis was definitely present post mortem, only seventeen per cent. appeared from their clinical histories to have consumed alcohol in any extent. Similar studies carried on by Sir James Barr[30] confirmed Cabot's observations. In excessive drinkers of all ages, only one-third exhibited definite thickening of the radial arteries, according to the observations of Bruce.[31] According to Herz,[32] in Austria-Hungary, alcohol scarcely ranks third in importance as the cause of arteriosclerosis. He has further observed that the peasants of that country who are notoriously consistent consumers of alcohol, are not particularly prone to

arteriosclerosis. According to Sir Clifford Allbutt, the ancient Egyptians, as well as modern orientals, were very liable to extensive and early senile arteriosclerosis, although it is a well-known fact that these people were most abstemious in the use of alcohol. Those who have asserted that alcohol produces arteriosclerosis by arterial constriction and elevation of blood-pressure are not upheld by the facts of experimental pharmacology, which clearly demonstrates that alcohol is not a vaso-constrictor but a vaso-dilator, especially so far as the peripheral vessels are concerned, and that a lowering rather than a heightening of the blood-pressure is the result of large doses of alcohol.

On the other hand, Thayer and Bush[26] found that 46.8 per cent. of their cases that showed palpable radial arteries had used alcohol in some degree. Next to excessive physical labor, they found alcohol apparently the most frequent cause for palpable vessels.

The entire question of the causative relation of alcohol to the production of arteriosclerosis is admittedly difficult to answer. It so frequently happens that those who are chronic alcoholics exhibit at the same time other conditions, such as syphilis, chronic infections, etc., which can be held equally as responsible for their arteriosclerosis; or in addition to the alcohol, they have been subjected to prolonged periods of physical overexertion. Although alcohol *per se* is probably not to be looked upon as one of the chief causes of arteriosclerosis, it is not going too far to regard alcohol as an important contributory factor, which when associated with physical overwork or the toxins of the acute or chronic infections, increases the liability of the arteries to degenerative changes. In the United States at least, this discussion is now probably of only academic interest. If alcohol is so important a factor in the production of arteriosclerosis, as many have claimed, then a decade under the present prohibition laws, if these are effective, should be sufficient to cause a noteworthy decrease in the incidence of arteriosclerosis among those classes of the community that heretofore have been in the habit of consuming alcoholic drinks in excess.

Tobacco, like alcohol, has been frequently condemned as a cause of arteriosclerosis. Here again convincing proof is

difficult. There is pharmacological evidence that nicotin tends to raise arterial pressure. In this way the excessive and prolonged use of tobacco may lead to arteriosclerotic changes. As Sir Clifford Allbutt aptly puts it: "Moreover, tobacco, if it is much of a poison, is a very slow poison; at any rate, to most persons, so that its effects being mingled with the other conditions of senility, are almost impossible of discrimination." Tobacco is rarely the cause of arterio- sclerosis in young individuals; and those who have developed arteriosclerosis after the age of fifty, but who for years have smoked excessively, usually manifest so many other causes for their arteriosclerotic changes, that it is difficult, if not impossible, to hold tobacco responsible. On the other hand, numerous instances of marked arteriosclerosis may be found in both men and women who have never used tobacco in any form. On the whole, it is extremely doubtful whether to- bacco, if used in moderation, has any deleterious effect so far as the blood-vessels are concerned.

Among other exogenous poisons should be mentioned lead. There seems no doubt that chronic lead poisoning may bring about, even in young people, definite arteriosclerotic changes. Lead operates in this way by inducing a persistent hypertension that ultimately leads to permanent arterial changes. According to Warfield[2] the workers in paint fac- tories, where various forms of lead are handled, develop arteriosclerosis early in life. The arterial lesions of lead poisoning tend to develop independently of any complicating renal disease. Chronic lead poisoning the result of the long continued ingestion of food, water or of other beverages con- taminated by lead, has been known to lead to arteriosclerosis.

Tea and coffee may be mentioned as other exogenous poisons that have been held responsible for arteriosclerosis. These substances do raise blood-pressure, and it is pos- sible that in this way they may in some instances produce vascular degenerative changes. On the other hand, their employment is so general, and so many people that use tea and coffee constantly also present other causes for arterio- sclerosis, that it is difficult to definitely fix the blame on these substances. Various substances such as adrenalin, physostigmine, lactic acid, and cholesterin when administered

by mouth, or intravenously to experimental animals, have produced what resembles in some respects human arterio-sclerosis. Although highly suggestive it is probably not justifiable to apply the results of such work to the disease as it is found clinically in man.

It is more than likely that certain toxic substances, elaborated within the body as the result of perverted or disturbed metabolism, are of greater importance than has hitherto been believed in the production of arteriosclerosis, but, as Allbutt has remarked: "We find ourselves poor in knowledge but rich in conjecture when we attempt to discuss the rôle of endogenous poisons in the production of arteriosclerosis." Certain diseases, such as chronic nephritis, diabetes, and gout, are frequently associated with arteriosclerosis. It has been generally held that the cause of arteriosclerosis in these conditions is due either to the elaboration of endogenous toxins or the failure to eliminate certain substances. Such an explanation, however, is largely suppositious, since the exact nature of these poisons is unknown. If such poisons do exist, it is not clear whether they produce arteriosclerosis by first causing vascular spasm and hypertension which leads to arteriosclerotic degeneration, or whether direct injury to the vessel walls is responsible for the degenerative change.

All forms of nephritis, particularly the chronic varieties, are associated with more or less arteriosclerosis. In the vast majority of instances such arteriosclerosis is associated with elevation of the blood-pressure. Abundant clinical evidence indicates that in this association, the renal disease is the primary causative factor, but what toxin or toxins are at fault, and just how renal disease brings about hypertension with the associated or subsequent arteriosclerosis, is still a matter for conjecture.

Arteriosclerosis frequently develops in the course of long standing cases of diabetes. When it occurs in the course of this disease it is nearly always of the senile or involutionary type. In spite of the widely expressed belief to the contrary, Joslin[33] says that diabetes is not a direct causative factor of arteriosclerosis. In support of this belief, he cites the fact that arteriosclerosis is seldom observed, even in the more

severe cases of diabetes in youth or middle age.   Further,
he states that sugar and acetone in the urine do not injure
the arteries or kidneys.   A study of the blood-pressure in a
series of these diabetics is confirmatory of this statement.
Joslin found that only nineteen per cent. of the cases occur-
ring between the ages of twenty-one and fifty exhibited a
blood-pressure of over one hundred and fifty, and that sixty-
seven per cent. of the patients of fifty-one years of age and
over showed a blood-pressure between one hundred and one
hundred and fifty.   Janeway[34] and Elliott[35] are also of the
opinion that diabetes *per se* has no influence on arterial pres-
sure.   From these observations it would seem that the oft
repeated assertion that diabetes is a cause of arteriosclerosis
is not borne out by the facts.   When the two conditions occur
together, the arteriosclerosis is more likely an expression of
advancing years than the direct result of the diabetes.   On
the other hand, Joslin and others have pointed out the pos-
sible rôle that arteriosclerosis may play in the production of
diabetes.

Gout has always been held as one of the causes of arterio-
sclerosis, particularly in England, where gout appears to
be much more common than in the United States.   Nearly
all cases of protracted gout, exhibit some thickening of the
peripheral vessels, usually associated with hypertension.
Since the nature of gout is obscure, the method by which
it may produce arterial changes is unknown.   The increase
in blood uric acid which commonly occurs in gout may be
a factor in producing the arterial changes.   On the other
hand, disturbances of renal function amounting to a true
chronic interstitial nephritis, usually met with in gout, may
be responsible for any arteriosclerotic changes.   It is also
probable that whatever the cause of gout may be, it like-
wise brings about the changes in the arteries and kidneys.

Too little attention has been paid to the gastrointestinal
tract as a possible, indeed probable, source of endogenous
poisons capable of producing arteriosclerosis.   Little reliable
data is available on this point, although many theories based
on speculation have been advanced.   In view of the fact that
constipation may lead to a rise in blood-pressure, Hertz[36]
suggests that chronic intestinal stasis may aid in the pro-

duction of arteriosclerosis, especially if this rise in blood pressure is in any way due to the direct action of poisons on the blood-vessels. The nature of such poisons is not understood, but by many they are believed to be the end, or by-products, of protein digestion. This seems the more likely since, as Warfield[2] states, "a dog fed for a long time on putrefied meat develops inflammation and degeneration of the adventitia and media." The same author cites the fact that guinea pigs, when fed indol in small doses by mouth for a long period of time, showed atheromatous degeneration of the aorta. It is quite generally believed that a diet high in protein is especially liable to bring about arteriosclerosis. These observations, coupled with the fact that arteriosclerosis is not infrequent in those who have suffered from long standing constipation, and further that in many cases of arteriosclerosis, especially those associated with high tension, colonic irrigations and other measures designed to keep the intestinal tract thoroughly emptied, frequently bring about an amelioration of the condition, all suggest the likelihood that putrefactive products elaborated in the intestinal tract may be an important cause of arteriosclerosis.

Overeating. Overeating has always been looked upon as one of the chief causes of arteriosclerosis. The question is by no means a settled one. Many individuals who have been excessive eaters, arrive at old age with neither an elevated blood-pressure nor thickened arteries. In others, again, the excessive ingestion of food over a long period of time, seems to be the only definite factor in the production of arteriosclerotic changes. It is more than likely that overeating should be used in a relative rather than an absolute sense. Undoubtedly individuals differ widely in their food requirements. A diet that may put an excessive burden on the metabolism of one person, may be readily handled by another. The ingestion of large quantities of food causes active congestion of the portal and splanchnic circulation with at least a local rise in blood-pressure. This process, frequently repeated, may bring about permanent changes in these important vascular areas. It is thought by some that such changes may be reflected in a rise in general arterial pressure that may finally bring about a more generalized arterio-

sclerosis. Although the question is still an open one, it may be said that in general the ingestion of large quantities of food over a long period of time, especially in those who take insufficient bodily exercise, frequently results in the production of arteriosclerosis.

There has been much discussion as to whether certain types of food are more likely to produce arteriosclerosis than other varieties. It is generally held that the excessive use of protein foods, especially when they are richly prepared and highly seasoned, is especially prone to produce arteriosclerosis. Although such a belief is firmly established in the minds of many, it is based more upon conjecture than upon demonstrated scientific facts. The development of arteriosclerosis probably depends not so much upon the quality of the diet, as upon the quantity. Regardless of its composition, a diet nicely adjusted to the metabolic peculiarities and caloric needs of an individual, is far less likely to cause vascular changes than a diet that is in excess of such needs, and the fact that arteriosclerosis is not an invariable accompaniment of overindulgence in food, makes it seem possible that some other factor as yet unknown, but possibly toxic, must be present before overeating will produce arteriosclerosis.

The relationship that has been pointed out between obesity and arteriosclerosis, should be considered in this connection. The two conditions are usually found associated, in which case they are probably due to one and the same cause, namely, overeating. Obesity itself is in all likelihood not an important nor common cause of arteriosclerosis, since it has been shown that blood volume is diminished in stout persons. If obesity of itself ever causes sclerotic changes, it possibly does so by mechanical interference with the portal and splanchnic circulation.

High Blood-pressure. By far and away the most important cause of arteriosclerosis, especially in middle age, is persistent elevation of the blood-pressure. Persistent high blood-pressure results from two main causes: (1) Primary disturbance of the vessels themselves, probably the result of arteriolar spasm, a condition termed by Janeway "hypertensive cardiovascular disease," named by Sir Clifford Allbutt

"hyperpiesia," and today generally referred to as "essential hypertension"; or (2) chronic renal disease. In either event the long continued high pressure may, and usually does, result in the development of secondary arteriosclerotic changes.

In a consideration of the vascular changes that are observed in middle life, the relationship of high blood-pressure to the production of arteriosclerosis, assumes great importance. At the outset it should be stated clearly that high arterial tension and arteriosclerosis are in no sense synonymous. The two conditions may, and frequently do, exist entirely independent of each other. A study of the material in any large city hospital, such as the Philadelphia General Hospital, soon makes it apparent that there are many patients who exhibit extreme degrees of arteriosclerosis, even to tortuosity and beading of the peripheral vessels, without any noteworthy rise in arterial pressure. On the other hand, it is a common occurrence, especially in private practice, to encounter individuals who for years exhibit marked elevation of blood-pressure without any demonstrable evidences of arterial thickening. Sooner or later, however, in most individuals, the long continued high blood-pressure—regardless of its cause—leads to definite arteriosclerotic changes in the vessels, hence the common association of hypertension with arterial degeneration.

The exact relationship which exists between high blood-pressure and arteriosclerosis has been a subject of much controversy. The belief at one time freely expressed, that arteriosclerosis is the cause of hypertension, is not supported by experimental and clinical observations. All available evidence seems to indicate that the converse is true, and that at least certain forms of arteriosclerosis are the result of persistent high blood-pressure.

The etiological relationship of high blood-pressure to arteriosclerosis was definitely established by the experimental work of Josué,[37] who induced a marked elevation of blood-pressure in rabbits by repeated intravenous injections of adrenalin, which resulted in the production of definite sclerotic changes in the aorta. Two years later this work was abundantly confirmed by W. Erb, Jr.[38] Many subsequent observers have shown the frequency of arteriosclerotic lesions

in animals following repeated injections of adrenalin, nico-
tin, barium chlorid and other substances which tend to
raise blood-pressure. That the arteriosclerosis produced by
these drugs is not primarily due to the toxic effect of the
drugs themselves on the vessel walls, but is the result of the
high blood-pressure produced by them, is suggested by the
work of Harvey,[39] who produced arteriosclerosis in rabbits
by repeated digital compressions of the abdominal aorta, for
a number of days; and especially by the striking experiments
of Klotz,[40] in which he induced marked hypertension in
healthy young rabbits by suspending them head downward
for three minutes every day for one hundred and twenty
days. At the end of this time, he found that the heart had
hypertrophied and that there had developed medial degen-
eration and diffuse dilatation of the thoracic aorta. Further-
more, pathologists have pointed out that arteriosclerotic
changes are particularly liable to occur in those parts of the
vascular tree where the direct effect of compression is
greatest and on points of constriction.

The clinical evidence is equally suggestive. If arterio-
sclerosis produced hypertension, it would be difficult to ex-
plain the practically normal pressures observed in the great
senile group of arteriosclerotics with rigid, pipe-stem vessels.
On the other hand, there is an abundance of clinical evidence
to show that in a large number of the individuals who
exhibit high blood-pressure, the hypertension began in early
adult or in middle life, and preceded by many years the
development of demonstrable arteriosclerotic changes. When
arteriosclerosis and high pressure co-exist, in the light of
our present knowledge, it seems justifiable to look upon the
hypertension as an antecedent condition of fundamental etio-
logical importance in the production of the arteriosclerosis.
It may be that future work will show that this conception
is incorrect, and that arteriosclerosis and the preceding
hypertension are both the result of one and the same under-
lying cause.

A discussion of the manner in which hypertension of
primary vascular origin is brought about, may properly be
referred to the section devoted to essential hypertension, a
condition which merits independent consideration, because,

although essential hypertension is closely related to arterio-
sclerosis it is nevertherless, as has been said, not synonymous
with it.

The occurrence of hypertension and subsequent arterio-
sclerotic changes secondary to primary renal disease, is gen-
erally recognized. This important relationship has been
dwelt upon in the chapters devoted to renal disease, but for
the sake of completeness should also be touched upon here.

Arteriosclerosis, regardless of whether or not it is associ-
ated with hypertension, sooner or later gives rise to second-
ary sclerotic changes in the kidneys. In these instances the
changes in the kidney, like the changes in other organs of
the body, are secondary to and form a part of the general
manifestation of arteriosclerosis. On the other hand, in
primary renal disease, more especially in that chronic form
that involves chiefly the glomerular structures, and which
is variously known as "chronic glomerular nephritis,"
"chronic interstitial nephritis," "the small red kidney," "pri-
mary contracted kidney," etc., there occurs as one of the
obtrusive manifestations of the disease, marked persistent
rise in blood-pressure, and as the result of this hypertension,
arteriosclerotic changes are ultimately induced. In such in-
stances the cardiovascular changes are the result of the
underlying renal condition. It is in this way that chronic
renal disease, by inducing hypertension, acts as an etiological
factor in the production of arteriosclerosis.

Just how arterial hypertension is induced by chronic renal dis-
ease is not understood. According to Austin,[41] there is experi-
mental evidence showing that reduction of kidney substance to
about one-fourth the normal, leads to elevation of blood-pres-
sure. Since methods for studying renal function have come into
use, there has been a gradual accumulation of evidence tending
to show that there is a fairly constant relationship between im-
paired renal function and hypertension. Efforts to show that
increased adrenalin content of the blood in chronic nephritis is
responsible for elevation of blood-pressure, have thus far been
inconclusive. It may be said that at present the available evi-
dence indicates that the elevated blood-pressure encountered in
nephritis, results from impairment of the eliminative function of

the kidneys.   The exact mechanism by which such impaired function induces hypertension is not yet understood.

It must not be forgotten that in the condition known as essential hypertension the result of arteriolar spasm, or disease of the smaller vessels, secondary sclerotic changes are frequently observed in the kidneys.   These changes are unlike those found in the arteriosclerotic kidney and are also distinct from those that are characteristic of a true chronic nephritis.

To briefly recapitulate, therefore, there are three possible relationships to be thought of in considering the association that exists between renal disease, arteriosclerosis and hypertension. First, arteriosclerosis may be the primary condition and give rise to secondary sclerotic changes in the kidneys.   Second, the renal lesion may be the primary condition which by a poorly understood mechanism leads to hypertension which in turn leads to arteriosclerotic changes.   Third, the underlying condition may be essential hypertension, a primary disturbance of the smaller vessels, which leads to secondary vascular changes which involve the kidney as well as other organs of the body.

THE PATHOGENESIS OF ARTERIOSCLEROSIS.

From what has been said in the preceding pages, it is evident that arteriosclerosis may result from many causes, which in a general way may be placed in three main groups: First, the changes incident to age and work; second, a heterogeneous group of infections and toxic agents; third, the mechanical effects of over-strain incident to persistent high blood-pressure.   Frequently several of these causes are operative in one individual. At first thought it is difficult to understand how causes that are so varied are all capable of bringing about changes in the blood-vessel walls that are fundamentally so similar.   This difficulty can only be lessened by adopting some explanation of the pathogenesis of arteriosclerosis that is equally applicable to all of the diverse etiological factors.

Much controversy and discussion has arisen over the question of the manner in which arteriosclerosis is produced.   The older belief of Roktansky, Virchow and others that arteriosclerosis was the result of a chronic arteritis brought about by direct irritation of the intima, was largely superseded by the more satisfactory view advanced by Thoma.[42]

In brief Thoma held that the primary change was not the inflammatory condition of the inner coat of the artery, but a weakening of the media, which permitted a local dilatation of the vessel to occur. This widening resulted in slowing of the blood stream; then in order to reëstablish the normal lumen of the vessel, and so restore a proper relationship between the diameter of an artery and its contents, connective tissue was laid down in the subendothelial layers of the intima. The intimal thickening, therefore, was a compensatory process designed to strengthen the vessel at the point of weakness and also to establish a normal rate of blood flow. Thoma's observations marked a distinct step forward in our conception of the arteriosclerotic process. Nevertheless, there have been and are many, who are unwilling to accept Thoma's hypothesis, who deny that medial degeneration is always primary and find Thoma's ideas on local changes, stream velocity, and alterations in nutrition of the vessel wall difficult to understand.

It is the opinion of the writer that the most easily understood and most generally satisfactory theory of the manner in which arteriosclerosis is produced, is that advanced by Adami first in 1896,[43] but reaffirmed and elaborated upon in later works[44] by Adami and Nicholls.

The essential features of Adami's hypothesis may be stated in part in the author's own words, "there are two main causes for arteriosclerosis, either increased strain thrown upon the arterial wall by high pressure or a weakened state of the wall from congenital causes or from disease. If the pressure be normal but the walls weakened, the results are of the same order as when the pressure is heightened but the walls are of normal resisting power." In short, he believes that it is the ratio between the resisting power of the vessel walls and the pressure to which they are subjected from within that is the fundamental factor in the production of arteriosclerosis. Such a theory furnishes a reasonable explanation of the way in which the various causes of arteriosclerosis operate. Furthermore, such a theory explains why at one time arteriosclerotic processes may follow in the wake of a high blood-pressure, whereas at other times similar changes develop when the blood-pressure is normal or even below normal. In the first instance, to again cite the views of Adami, spasm of the arterioles brings about a general rise of blood-pressure which

secondarily affects the media of the aorta. The muscular structures of the media, as the result of the overwork thus imposed upon them, undergo degeneration, a gradual giving way results which brings about a local compensatory fibrosis of the intima. In the case of the smaller blood-vessels, a similar process is at work. Overstrain produces a gradual weakening of the musculature, which induces a diffuse fibrosis of the intima. On the other hand, in those instances that are not associated with a high blood-pressure, atrophy and degeneration of the media, the result of inherited weakness, or the involutionary changes of age, or injury of an infectious or toxic nature, cause the media to succumb even to a normal blood-pressure, with resulting dilatation and subsequent compensatory fibrosis of the intima. Later degenerative changes, referred to as atheroma, may take place in these areas of intimal hyperplasia. If the medial degeneration is too rapid or too diffuse, compensatory intimal proliferation cannot occur, and the result is the formation of an aneurism. Why at one time a diffuse or circumscribed compensatory thickening of the vessel wall occurs, whereas at another time this thickening is absent and the vessel wall dilates, is purely a matter of the degree of strain to which the vessel wall is subjected in relation to the strength of that wall. If the strain is moderate, the vessel wall relatively resistant, so that the giving way of the media is not excessive, the intima, which as the result of the media giving way becomes moderately stretched, reacts to this strain by a compensatory proliferation of its cells. On the other hand, with rapid and excessive medial giving way, the result of too great a strain, the intimal structures are incapable of adequate proliferation so that compensatory thickening does not take place. In brief, then, it may be said that the essential features of the production of arteriosclerosis are primary medial degeneration, the result of mechanical overstrain, the destructive action of toxins or the atrophy of age; followed by a diffuse or nodular hyperplasia of the intima, apparently protective or compensatory in nature.

THE PATHOLOGY OF ARTERIOSCLEROSIS.

With the possible exception of syphilis, the pathological changes observed in arteriosclerosis bear no definite relationship

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to the various etiological factors. Changes produced by syphilis are sufficiently distinctive to merit separate consideration. With this exception, regardless of its cause, arteriosclerosis may manifest itself in the aorta and larger vessels of some individuals, whereas in others it attacks chiefly the smaller arteries. Occasionally individuals are found in whom all vessels are more or less involved. This selective action of the arteriosclerotic process for certain vessels, indicates to Adami that all parts of the arterial tree are not equally resistant to strain, although the factor of strain as above discussed is in all probability fundamental to arteriosclerosis wherever it is found. The changes observed in the vessel walls differ to some extent according to the size of the arteries involved, and the variations in their structure.

Structural variations characteristic of arteries of different sizes must be borne in mind when considering the various changes produced by arteriosclerosis. The aorta and its larger branches contain a preponderance of elastic fibers, particularly in the inner and middle coats. The smooth muscle fiber in the media of these larger vessels is relatively insignificant in comparison to the dense network of elastic fibers which they contain. Such a structure gives to these vessels increased elasticity, thereby rendering them better able to withstand the repeated distending force of the blood propelled into them at each systole. On the other hand, in arteries of medium size, the media, comparatively speaking, is better developed and contains a larger amount of muscle and less elastic tissue. As arteries decrease in size, their coats gradually diminish in thickness, elastic tissue becomes progressively reduced, until in the arterioles the media consists almost entirely of muscle cells. By the time the capillaries are reached, the muscle cells have disappeared, and the capillaries are nothing more than endothelial tubes. The adventitia which in the larger arteries is a tough fibro-elastic outer coat, diminishes in thickness as the vessels become smaller, until in the smaller arterioles it becomes nothing more than a few strands of fibro-elastic tissue which is entirely wanting in the capillaries. The increase in muscle fiber and decrease in elastic tissue observed in the medium sized and smaller vessels, may be taken as an index that they are subjected to less distending force than the larger and more elastic vessels, but that on the other hand, they are more under the control of the vaso-motor system, and are required

to dilate and contract more actively in response to the varied functional demands of the organs which they supply.

The lesions of arteriosclerosis may be nodular or circumscribed, or diffuse. In the former they are usually limited to the aorta or some of its branches. These nodular lesions may be extremely few in number and widely scattered, or they may be exceedingly numerous and coalescent. Diffuse arteriosclerotic changes involve chiefly the smaller vessels; at times they may be so widespread as to affect the major part of the arterial tree. Although as a rule these two pathological types of arteriosclerosis occur independently of each other, in some cases of arteriosclerosis both types in all their varied degrees may be present in the same individual.

This tendency for certain vessels to be involved while others escape, must be further emphasized because of the important bearing it has upon the symptomatology and clinical manifestations of arteriosclerosis. The aorta may be the seat of a marked nodular change and yet its branches may be entirely free from all vestige of arteriosclerosis. Diffuse and at times even associated nodular lesions may be present in the peripheral vessels, such as the radials, yet the aorta may be entirely normal. It frequently happens that the vessels running to a certain organ such as the coronary arteries supplying the heart, or the cerebral vessels, may be markedly diseased and yet other portions of the body are found to be entirely free of degenerative vascular changes.

Before discussing the pathological changes observed in the nodular type of arteriosclerosis of the aorta attention should be called to certain intimal lesions that have been termed simple atheroma and which are generally looked upon as separate and distinct from the lesions of ordinary aortic arteriosclerosis These lesions are small, yellowish, white streaks involving the intima alone, and evidently the result of some nutritional disturbances in the deeper layers of the intima resulting in fatty degeneration. Such lesions may be found at any age and have usually been observed in those dying from acute infections. These intimal lesions are probably identical with or closely related to, the changes obtained in the arteries of animals inoculated with various organisms such as typhoid bacillus, *Streptococcus pyogenes, Staphylococcus aureus* and

other pathogenic bacteria by Oscar Klotz,[45] Saltykow,[46] Gilbert and Lion,[47] Crocq[48] and others. These observers found the bacteria or their toxins exerted a selective action upon the intima producing endothelial proliferation that later underwent hyaline and fatty degeneration and gave rise to lesions that resembled early atheroma as seen in man. Klotz and other experimenters failed to observe any secondary medial changes following this proliferative intimitis, and have used this fact as an argument to point out that all arteriosclerotic lesions do not have their beginnings in medial degeneration. On the other hand, Adami has suggested that this infectious proliferative intimitis may by reason of the thickening of the intima produced, cut off the nutrition of the inner layers of the media, thereby giving rise to degenerative changes in the media which lead to weakening, dilatation and further intimal proliferation. At present it is impossible to state the exact relation of these intimal lesions, the result of infection and intoxication, to nodular arteriosclerosis of the aorta.

The nodular lesions of the aorta are found irregularly scattered through the vessel. As a rule such lesions first appear at the points of greatest strain or where the layers of the vessel wall are weakened, that is, where the intercostals and other branches of the aorta are given off. The nodules are of various size, from one to ten or twenty millimeters in diameter. They appear as irregular raised plaques. At first they are grayish white in color, and are covered by smooth endothelium. Later on as degeneration takes place, they become of a more yellowish color, irregular and hard. At post mortem these nodules form distinct projections into the lumen of the aorta.

The classic and well known observations of Thoma[49] indicate that during life the surface of the aorta in these nodular forms of arteriosclerosis is smooth, and that the endothelial projections which appear at post mortem are in reality areas of intimal proliferation which fill up small depressions or bays in the aortic wall that have resulted from primary medial weakening and giving way. Thoma found that when a freshly removed aorta was filled with warm tallow or wax at ordinary blood-pressure, and then allowed to harden, the resulting cast of the aorta had a perfectly smooth surface and did not show

depressions corresponding to the nodules seen on the inner surface of such an aorta.

Thoma's results have frequently been challenged, notably by Klotz,[50] who in a carefully conducted series of experiments was unable to confirm Thoma's results. Klotz found that observations made after injecting aortas with paraffin were unreliable because of the artifacts readily produced in the paraffin. He then devised a method by which it was possible to inject the aorta with water at a pressure equal to 160 millimeters of mercury. When the aorta was thus distended, it was frozen for a number of hours and careful observations were made upon the contour of the lumen of the aorta by sawing the frozen aorta into small disks one-half an inch thick. By this method he not only failed to confirm Thoma's earlier observations, but showed that even in an over-distended aorta, endarteritic plaques formed bulgings into the lumen of the vessel.

In spite of these conflicting observations, the weight of evidence seems to justify an adherence to the theory that in the nodular form of aortic arteriosclerosis, the initial damage is in the media which exhibits degenerative changes not only in the elastic tissue but also in the muscle cells. At the site of this medial weakness proliferation takes place of the fibrous and yellow elastic tissue of the overlying intima. This is a pure intimal hyperplasia and shows no signs of an inflammatory reaction. In an effort to strengthen the weakened areas in the aortic wall hyperplastic subendothelial intimal cells are laid down layer by layer. It is these layers of intimal proliferation that produce the nodules seen on the inner surface of the aorta.

Although the outer layers of the media receive their blood supply and nutrition through the vasa vasorum that course through the adventitia and dip into the more superficial structures of the vessel wall, the intima and inner layers of the media are nourished by filtration of the blood plasma from the lumen of the aorta. If this filtration of plasma is progressively interfered with by the layers of fibrous tissue laid down by the proliferating intima, only the most superficial layers of the intima continue to be nourished, while the deeper intimal structures and the inner layers of the media, undergo degenerative changes. This degeneration is manifested by hyaline changes

in the intercellular material and fatty degeneration of the cellular elements. This leads later on to a breaking down of the tissues, until finally in all but the more superficial layers of the atheromatous nodule the cells have been converted into a disintegrating mass of granular débris mixed with fat globules and cholesterin plaques. This necrotic area, covered as a rule by a layer of intact endothelium, forms what is frequently referred to as an atheromatous abscess. Sooner or later the layer of endothelium covering this abscess ruptures, discharging the atheromatous material into the lumen of the vessel. The discharge of this material leaves behind a shallow depression with a roughened face which represents the so-called atheromatous ulcer. If calcareous deposits have not already occurred in the atheromatous plaque, they, as a rule do occur at the site of the atheromatous ulcer. The association of atheromatous nodules in various stages of degeneration and these areas of calcified atheromatous ulcers, give rise to the well known roughened distorted appearance so characteristic of the later stages of nodular arteriosclerosis to which the term endarteritis deformans is applicable. It is worthy of note that in the non-luetic types of nodular sclerosis, there is a complete absence of efforts at regeneration of atheromatous areas. The vasa vasorum in the media do not give off capillary loops to penetrate the areas of necrosis as would be the case if the process were in any sense inflammatory. There is a complete lack of granulation tissue and therefore scars do not develop. Quite the contrary is true when the lesions are luetic, as will be pointed out later. This nodular form of arteriosclerosis of the aorta may result from various toxic or infectious causes other than lues, but it is frequently encountered as the result of prolonged hypertension, and for that reason is more characteristic of arteriosclerosis as seen in middle age, than it is of the senile form of the disease.

Although the nodular form of arteriosclerosis is found in the aged, senile arteriosclerosis is more apt to manifest itself in a different form. This type of the disease is frequently referred to as Moenckeberg's sclerosis, because he was the first to carefully describe the changes that occurred in this variety.[51]

Moenckeberg's type of arteriosclerosis which occurs in the senile, characteristically develops in those whose blood-pressure is normal or even below normal. The process may involve the aorta and its branches, but is often observed in the abdominal aorta and the iliacs, and frequently produces changes in the peripheral arteries such as the radial. The vessels involved are elongated, tortuous, lose their elasticity, and their walls are thin. This thinning is due to a primary degenerative change in the media. The middle layers of the media show the first alteration, and fatty degeneration of the muscle fibers takes place. The muscle cells are largely destroyed and calcareous deposits rapidly occur. Some efforts at intimal proliferation may take place, but as a rule in Moenckeberg's sclerosis there is not only no intimal thickening, but actual thinning occurs. The result of this medial degeneration with early calcareous deposits, is to give the involved vessel an irregular outline due to a succession of shallow sacculations or pouches, which run transversely to the long axis of the vessel and are separated by a ribbon of less degenerated tissue. This form of senile sclerosis may involve the peripheral vessels alone, leaving the larger central arteries untouched. The tortuous and beaded radial arteries so commonly palpated in older people, are examples of Moenckeberg's sclerosis and the beadings are produced by the calcareous deposits laid down separately in the areas of medial degeneration. Nodular and senile forms of arteriosclerosis may occur independently or may at times be associated, especially when several etiological factors are responsible for the arterioslcerotic changes. The aorta may be the seat of nodular sclerosis while the peripheral vessels show the Moenckeberg type.

Diffuse arteriosclerosis may exhibit any or all the changes above described but differs in this respect, that it involves particularly the smaller vessels. Diffuse arteriosclerosis exhibits essentially widespread thickening of the vessel walls. In the media this manifests itself not only as thickening of the elastic fibrous tissue, but also by marked hypertrophy of the muscular elements. There is also marked subendothelial proliferation of the intima. Sooner or later hyperplasia of the connective tissue of the adventitia occurs, and the entire arterial wall is involved in the process. Nodular changes and secondary de-

generative changes likewise take place. These are limited for the most part to the aorta and large vessels. When nodular changes are met with in the smaller vessels, they are less likely to undergo extensive atheromatous change. In diffuse arteriosclerosis calcareous deposits occur not only in the larger vessels but frequently in the vessels of smaller caliber, such as the cerebral, the peripheral and the visceral arteries. In the arteries of moderate size the calcareous deposits are found chiefly in the media, and may be sufficiently extensive to convert these vessels into rigid tubes. Actual bone formation has sometimes been observed in these vessels. In the smaller vessels hyperplasia of the intima may become so extreme as to partially or completely occlude the lumen of the vessel giving rise to a condition referred to as endarteritis obliterans.

When the arterioles become involved in a diffuse arteriosclerotic process, they may exhibit either a diffuse hyperplasia of the intima, or marked hypertrophy of their muscular structures. In connection with the diffuse arteriosclerotic changes in the arterioles and smaller vessels, peri-arterial fibrosis, or chronic peri-arteritis are not infrequently encountered. Why this should occur, is not understood.

The one form of arteriosclerosis that can be connected definitely to a specific etiological factor, is that produced by syphilis, one of the most frequent causes of arteriosclerosis in middle age. Arteriosclerotic changes due to syphilis are more common in men than in women. They are particularly likely to occur in young men or in early middle life, in most cases developing between the ages of thirty-five and forty-five years. Syphilis may cause lesions in any part of the vascular tree, but the site of election is the aorta. As was pointed out under etiology there is no question but that syphilis is responsible for certain vascular lesions. Heller was among the first to call attention to this association.[52] His observations have been abundantly confirmed by many observers. Chiari,[53] Schmorl,[54] Wright and Richardson,[18] Benda,[55] and others have all pointed out the relationship between lues and particularly chronic disease of the aorta, in many instances confirming their observations by Wassermann reactions and the actual finding of the *Spirocheta pallida* in the syphilitic aortitis.

Unlike other forms of arteriosclerosis, syphilis attacks usually the root or the ascending part of the aortic arch. By involving the walls of the sinuses of Valsalva, luetic lesions of the aorta frequently occlude partially or completely the orifices of the coronary vessels. The aortic lesions are usually nodular and circumscribed, involving only a small strip of the first part of the aorta, while the rest of the vessel is little changed. More rarely the lesions are found scattered through the ascending portion and arch of the aorta.

The macroscopic appearance of syphilitic lesions of the aorta is characteristic. Instead of having the usual yellowish-white elevated appearance of the nodules so commonly seen in other forms of arteriosclerosis, syphilis produces in the aorta shallow depressions frequently stellate and puckered and of a blueish-white color. The puckered appearance is so persistent and characteristic, that it is in itself diagnostic of luetic aortitis. There is a marked tendency for these syphilitic lesions to occur in the first part of the aorta, to spread downward and to involve the aortic valve, giving rise to aortic insufficiency, with all its usual manifestations. The close relationship between aortic insufficiency and syphilitic disease of the aorta, has been admirably pointed out by Longcope[20].

Microscopically syphilitic lesions of blood-vessels differ from other forms of arteriosclerosis. The infectious agent enters the walls of the vessels through the vasa vasorum, about which in the adjacent media there is set up a definite, perivascular, round cell infiltration inflammatory in character. The inital lesion is therefore a true mesoaortitis. As the result of this round cell infiltration of the media rapid atrophy and destruction of both the elastic tissue as well as the muscle fibers of that layer takes place. Perivascular infiltration with subsequent productive changes also takes place in the adventitia. As a result of the medial changes, the intima as a rule, proliferates. Later on, this area of intimal thickening undergoes the usual fatty and hyaline degenerative changes characteristic of atheroma. After these atheromatous changes have occurred, capillary loops arise from the vasa vasorum in the media and push up into these necrotic areas, producing granulation tissue which subsequently brings about healing. In this way the characteristic puckered stellate scars of the intima above re-

ferred to, are produced. Luetic lesions of the aorta, therefore, differ clearly from the ordinary arteriosclerotic processes, in that they are inflammatory and not purely hyperplastic. Primarily lues causes a true mesoaortitis which tends to heal with the production of granulations and scar tissue. Not infrequently a luetic lesion of the aorta progresses so rapidly that intimal thickening fails to occur, the aortic wall gives way and an aneurism results.

In addition to this characteristic mesoaortitis, syphilis may involve the blood-vessels in other ways. Diffuse arteriosclerotic changes in the smaller vessels may result from syphilis. When the smaller vessels are the seat of luetic disease intimal thickening is apt to be marked, the hyperplasia often being sufficiently great to occlude the vessels. Luetic disease in the smaller visceral vessels is not uncommon and is especially prone to occur in the vessels of the central nervous system.

As a result of arteriosclerosis associated pathological changes occur in other organs. Any organ may be involved, the degree of anatomical change and functional impairment depending entirely upon how much occlusion of the circulation there is as the result of the arteriosclerotic changes in the vessels that supply the organ in question. The heart, brain and kidneys are the organs that most frequently suffer marked changes as the result of arteriosclerosis.

The heart may be involved in two ways. If arteriosclerosis is associated with or preceded by persistent high pressure, the extra load thrown upon the heart by this hypertension, brings about marked hypertrophy, particularly of the left ventricle. As the disease progresses, such an hypertrophied heart muscle ultimately undergoes degenerative changes, until finally chronic cardiac dilatation with its attendant phenomena are added to the picture. The second way in which the heart may be involved is due to the gradual occlusion of the circulation by reason of arteriosclerosis of the coronary arteries or because of arteriosclerotic patches in the aorta which partly occlude the coronary orifice. Under such conditions degenerative and fibroid changes rapidly occur leading sooner or later to cardiac failure, unless as frequently happens, the disease is terminated

more abruptly by the onset of angina pectoris the outcome of a disturbed coronary circulation or aortitis.

Under diseases of the kidneys, reference has been made to the form of renal sclerosis that so commonly forms a part of the picture of arteriosclerosis. It must be remembered that in renal arteriosclerosis the kidney changes are but part of a general arteriosclerotic process; they are a result but in no sense a cause. These secondary renal manifestations must be clearly differentiated from the chronic forms of nephritis that give rise to hypertension and secondary vascular changes. In the late stages of arteriosclerosis when the kidney has undergone considerable secondary change, it may be exceedingly difficult to clearly draw the line between renal arteriosclerosis and primary chronic nephritis with its associated vascular phenomena.

The kidney which is the seat of pure uncomplicated arteriosclerotic changes, may be of normal size or slightly reduced. Its surface is somewhat uneven and granular, and it is firmer than normal in consistence. The capsule is somewhat thickened and adherent, the cortex is usually somewhat reduced in size, and is frequently the seat of small cysts. There is some interstitial overgrowth of connective tissue, resulting in atrophy and degeneration in scattered areas of the parenchyma. The most conspicuous as well as the primary lesions are found in the blood-vessels. When the kidney is sectioned, the larger blood-vessels stand out with rigid thickened walls and wide open lumina. Microscopically the Malpighian bodies show hyaline degeneration; while definite thickening and sometimes occlusion of the renal vessels because of intimal proliferation, is observed.

The most serious effect of arteriosclerosis upon the brain occurs in those cases in which the vascular degeneration is associated with high pressure, and in whom hemorrhage is an ever present possibility and always a serious catastrophe. Although any cerebral artery may rupture giving rise to destruction of the adjacent nervous tissue, lesions of the internal capsule producing more or less complete hemiplegia and hemianesthesia, due to rupture of the lenticulo striate artery, are by far the most common. Thrombosis of the cerebral vessels frequently occurs. Although thrombosis is said to be more

frequent in the basilar arteries than in any other vessels, it it may occur in any part of the brain. Endarteritis of luetic origin, and ordinary atheroma are chiefly responsible for the development of thrombi. Not infrequently an obliterating endarteritis of the cerebral vessels develops slowly resulting in gradual atrophy and degeneration in various portions of the brain, ultimately leading to cerebral softening.

What has been said in the foregoing discussion of the pathology of arteriosclerosis, refers to changes in the arteries. It should be remembered, however, that the veins may also be attacked by a chronic inflammatory degenerative process termed phlebosclerosis. Phlebosclerosis may be observed in local groups of veins or it may be a wide-spread and general process. In the latter, it is usually associated with arteriosclerosis. The various toxic and infectious causes that are responsible for arteriosclerosis may induce these changes in the veins also. Local thickening of the veins is usually the result of a thrombo-phlebitis or some local obstruction. Veins that are poorly supported are more likely to be affected than others; hence phlebosclerosis is more common in the superficial veins of the extremities than elsewhere. Intimal hyperplasia and proliferation of the connective tissue cells of the media are the commonest changes observed in phlebosclerosis. These sclerotic changes in the veins are more common than is generally supposed, and are not infrequently encountered in comparatively young people. By many this condition of the veins is looked upon not so much as a true inflammatory condition, as a hyperplasia due to strain.

ESSENTIAL HYPERTENSION.

Although there is good authority for considering essential hypertension and its results as part of the arteriosclerosis, it seems more appropriate in the light of recent observations to look upon essential hypertension as a clinical entity deserving of separate discussion. It has already been emphasized that persistent high blood-pressure is in no sense synonymous with arteriosclerosis; although the former condition is frequently responsible for the changes in the blood-vessels that are recognized as arteriosclerosis, so that it is not unusual to find the

two conditions associated. Sir Clifford Allbutt in 1904 was the first to emphasize the existence of persistent primary high blood-pressure independent of arteriosclerosis and to insist that arteriosclerosis not only does not cause high blood-pressure, but in a large percentage of cases exists without any undue hypertension. Allbutt gave to this condition of primary hypertension the name hyperpiesia. It required ten years for Allbutt's views to gain much acceptance. Since 1905 many clinical and pathological observations by numerous observers, have confirmed in the main, Allbutt's contention; so that today there are ample grounds for considering essential hypertension as a separate and distinct condition, although admittedly one that is closely allied to arteriosclerosis. If essential hypertension is not considered by itself, but is taken up as part of arteriosclerosis, the objection might be raised with propriety that it is no more a part of arteriosclerosis than it is of renal disease, and that hypertension could, with equal reason, be considered under diseases of the kidney; since, just as arteriosclerotic changes frequently follow in the wake of persistent hypertension, so inevitably in the course of this disturbance secondary changes occur in the kidney. Therefore, though freely admitting the close and often confusing relationship that exists between primary hypertension on the one hand and secondary changes in the arteries and kidneys on the other, it seems best to consider essential hypertension as a separate and distinct disease entity.

By essential hypertension is meant a condition of persistent elevation of both the systolic and diastolic blood-pressures, for which there is no discoverable cause. A sharp distinction must be drawn between the hypertension that is secondary to various forms of chronic renal disease and essential hypertension. The latter must also not be confused with conditions in which there is a high systolic pressure with a low diastolic pressure, as encountered in aortic insufficiency.

Etiology. The exact cause of essential hypertension is unknown. In spite of much speculation there is no proof as to the exact mechanism that produces and maintains the persistent high tension. The presumption is that either through nervous influences or because of some toxic substances, arteriolar spasm is brought about. The persistence of this spasm

leads to an abnormal increase in the peripheral resistance. In order to overcome this increased resistance so as to maintain bodily function the blood-pressure becomes elevated. If this assumption is correct, then a persistently high blood-pressure must be looked upon as a compensatory and conservative process, essential to the maintenance of proper body function.

There are some who believe that the increased resistance is not in the arterioles but rather in the capillaries. This conception has been warmly advocated by Litchfield.[56] There are others who maintain that the important factor in increased blood-pressure is the viscosity of the blood. Moscher[57] has recently dwelt upon this possibility. The probable importance of viscosity in relation to blood-pressure has long been recognized, and the subject has been carefully investigated by many able workers in the laboratories of this country and Europe. The problem is a complicated and difficult one and for that reason it has never been accorded the clinical importance that it doubtless deserved. The relationship of the viscosity of the blood to heightened blood-pressure, is as yet too little understood to justify any conclusion being drawn.

Many factors have been held responsible for the arteriolar spasm that induces persistent hypertension. Numerous observers have held that in all cases of hypertension the kidneys are in reality responsible for the elevated blood-pressure. Such a position is untenable in view of the fact that in most cases of essential hypertension renal manifestations are entirely wanting, or if present are inconstant, slight and late phenomena. The absence of noteworthy or primary renal lesions in essential hypertension, has been repeatedly emphasized by many writers such as Graham Steell,[58] Janeway,[59] Stengel,[60] Osler,[61] and Riesmann.[62] On the whole there can be but little doubt that essential hypertension is a condition that develops independently of any underlying renal disease.

The toxins of local and general bacterial infection, as well as the various endogenous and exogenous toxins, have been held accountable for the arteriolar spasm underlying essential hypertension. Alcohol, tobacco, and the long continued ingestion of a high protein diet are regarded by some as factors of etiological importance. Recently Allen[63] has pointed out the probable bearing of disturbed sodium chloride metabolism

on the production of hypertension. Syphilis does not appear to be a consistent factor of much importance in the production of essential hypertension. In the writer's experience a positive Wassermann reaction is but rarely encountered in this condition, certainly as it is met with in private practice.

The most likely cause of hypertension is some disturbance of the nervous system capable of bringing about arteriolar spasm. This is the more likely in as much as the condition is observed chiefly in those who are high strung and live at a tension rather than in those who are more placid. It is well known that psychic and nervous strains are capable of producing considerable elevation in blood-pressure. The onset of essential hypertension frequently is preceded by or coincident with periods of worry and nervous overstrain, all of which points to the probable importance of the nervous system in bringing about this state of persistent high pressure.

The rôle of the glands of internal secretion in the production of essential hypertension, has of late attracted considerable attention. In women, essential hypertension is likely to make its appearance at or about the time of the menopause. Cases of this character have been referred to as climacteric hypertension. It has been held by many that the disturbance of internal secretion incident to the ovarian changes that accompany the menopause are responsible for the persistent rise in pressure observed at this time. Menopausal hypertension has been studied particularly by Torrey,[64] Hopkins,[65] Riesman,[66] Wright[67] and Cummings.[68] It is impossible to say whether the menopausal changes are responsible for the hypertension or not, but the frequency with which hypertension is associated with this period of life makes such a supposition highly probable.

In view of the blood-pressure raising property of adrenalin, it has been suggested that essential hypertension is due to some disturbance that leads to hyperfunction of the adrenal glands. Such a theory is undeniably tempting, but it must be admitted that at present there is no definite evidence in support of it, and our present knowledge of perverted internal secretion is too meager to justify such a conclusion.

In some instances hyperthyroidism appears to be responsible for essential hypertension. In the course of frank hyper-

thyroidism, increased blood-pressure frequently occurs, but it is doubtful whether increased thyroid activity is often the cause of essential hypertension when other evidences of thyrotoxicosis are wanting. Cases occur, however, that strongly suggest the possibility of a thyroid origin for some instances of hypertension. As for example, a young woman, aged thirty-nine years, who was recently observed by the writer, gradually developed a marked and persistent elevation of blood-pressure, systolic blood-pressure 200, diastolic 120. This hypertension was associated with marked hypertrophy of the left ventricle, but careful urinary studies and functional kidney tests failed to show the presence of any renal involvement. A slight diffuse enlargement of the thyroid gland was present, and her basal metabolism was plus 59. The absence of any other demonstrable cause for the hypertension, made it seem possible that in this instance the thyroid activity was the underlying factor.

Disturbances of the pituitary gland may also be a factor in some cases of essential hypertension. A case in which such a possibility existed, recently came under observation. The patient was an obese, flabby, married woman aged forty years. For many years she had had a persistent high blood-pressure, systolic 220, diastolic 140. There were no urinary or renal functional evidences of kidney disturbances. She had a poor sugar tolerance, and from time to time she had a mild glycosuria. She gave a history of excessive obesity which began at about the age of twelve years and which had persisted. In the absence of any other cause and with the obvious existence of pituitary dysfunction, the latter condition seemed responsible for the hypertension. In another case of frank acromegaly of long duration, high pressure, systolic 200, diastolic 130, developed. Instances such as the above suggest the probability that in some cases at least, essential hypertension is brought about by endocrine disturbances.

The greatest number of cases of hypertension occur between the fortieth and sixtieth years. Janeway[69] found that between eighty per cent. and ninety per cent. of his cases of hypertensive cardiovascular disease occurred between the ages of forty and sixty years. The condition, however, may develop at any age. Cases are on record in which it has been observed

in children. In the writer's series, the youngest case of primary hypertension unassociated with renal disease was that of a man aged twenty-two years. It is rare to have the condition begin after sixty, as essential hypertension is preëminently a disturbance of middle age. According to most observers, the condition is noted with equal frequency in both men and women. Personal experience is somewhat at variance with this general statement. In the writer's series, persistent high blood-pressure, the result of essential hypertension, was almost twice as common in women as in men. On the other hand, high blood-pressure secondary to chronic nephritis, occurred in twenty-five per cent. more men than in women. In women the cases of high blood-pressure due to essential hypertension, equalled in number the cases of hypertension that were the result of chronic kidney disease, whereas in men chronic nephritis caused a persistent high blood-pressure over twice as often as did essential hypertension. In the writer's series, this difference in the incidence of essential hypertension in the two sexes, is accounted for by the fact that many of the women examined were passing through the menopause and exhibited hypertension of probable climacteric origin.

Essential hypertension seems to be a product of modern strenuous city life. It is more common in the cities than in the rural districts, and in those who live at a tension and are actively engaged in business or the professions, than in those who live more outdoor active lives. The condition is observed more frequently among the well to do, than among the poorer classes. The energetic, successful, high-strung men and women who are over-nourished, drink too much, and exercise too little, furnish the bulk of those who are sufferers from essential hypertension.

THE PATHOLOGY OF ESSENTIAL HYPERTENSION.

Fundamentally essential hypertension is held to be the result of arteriolar vaso-constriction. Such being the case, the pathological changes observed in the vessels themselves, are either inconspicuous or entirely wanting, especially in the early stages. All the anatomical changes that occur are due to the secondary effects of this vascular spasm upon other organs. The organ which suffers first is the heart, which promptly

develops left ventricular hypertrophy. As the disease progresses this cardiac hypertrophy becomes greater and may reach enormous dimensions, but if the hypertension persists, sooner or later degeneration takes place in the cardiac muscle and not infrequently the coronary vessels themselves become involved and finally chronic cardiac dilatation may supervene. After the vascular spasm has persisted for some time, the smaller blood-vessels show a diffuse hypertrophy of the muscular elements in their coats, but as a rule, few if any marked changes are observed in the larger vessels.

Until the condition has persisted for some time, there are no noteworthy renal changes. Later on the kidneys become deep red in color and slightly granular. On section the renal vessels are found to show a certain amount of thickening. This thickening is said to be largely medial in character. Such renal changes are purely secondary and can in no sense be regarded as causative of the vascular condition. The kidneys in essential hypertension never show the marked alterations so characteristic of the red granular kidney of interstitial nephritis, or the marked degenerative changes common in the arteriosclerotic kidney.

As was pointed out in discussing the etiology of arteriosclerosis, the constant strain put upon the vessels by persistent hypertension gradually brings about anatomical changes in the vessel walls, until finally true arteriosclerotic processes develop; then the condition ceases to be one of essential hypertension and must be looked upon as a true instance of arteriosclerosis associated with a high blood-pressure. In contradistinction to the cases of arteriosclerosis the result of the involutionary processes of age in which the peripheral vessels frequently suffer the most, in these instances of hypertensive arteriosclerosis, the most marked changes are observed in the aorta and visceral arteries, and of the latter, the vessels of the brain, heart and kidneys show the most marked changes. Indeed the subsequent clinical course of cases of essential hypertension depends largely upon which of these three organs suffers first, or which sustains the most serious damage.

SYMPTOMATOLOGY IN ESSENTIAL HYPERTENSION.

Many cases of essential hypertension exist for a long time without presenting any symptoms. In many individuals the first evidence of the disease is the accidental discovery during the course of a routine medical examination, of an elevated blood-pressure. As these individuals are usually high-strung and sensitive, it not infrequently happens that on the first examination the blood-pressure readings are from 20 to 40 millimeters of mercury higher than those obtained at subsequent examinations, when the patient is no longer apprehensive. This fact must be borne in mind, and conclusions as to the height of the blood-pressure should not be arrived at until ample opportunity has been given not only to allow all fear and nervousness on the part of the patient to subside, but also for repeated blood-pressure readings to be made. Nothing should be done to alarm a patient about an elevated blood-pressure. Much harm frequently results from thoughtlessly telling patients after the first examination that their blood-pressure is too high; when as a matter of fact, subsequent examinations with the patient relaxed and at ease frequently give very different results.

Patients who are suffering from essential hypertension, especially in the early stages of this disorder before secondary changes have taken place in the blood-vessels, heart or kidneys, as a rule look remarkably well. They are active and strong, their color is good, and they are well nourished. More often than not, they are rather overnourished and have a tendency to corpulency. In the writer's experience this is particularly true of the women who develop an elevated blood-pressure at or about the time of the menopause.

The mental attitude of many of these patients is characteristic. They are always on a tension and are impatient, restless and frequently irritable. The men who suffer with essential hypertension are usually successful and aggressive business or professional men, whose lives are entirely engrossed in their work. They pride themselves on never having taken a vacation, and feel that they are indispensable to the success of every project in which they are engaged. Similarly the women with hypertension are inclined to worry unduly over

details; they are exacting, easily excited, and lack repose.
They are prone to make a tremendous burden of personally
supervising the conduct of their households, or else they rest-
lessly rush from one social activity to another. Eli Moscho-
witz[70] has admirably described the psychology of a case of es-
sential hypertension.

Although some patients present no symptoms except the ele-
vation of blood-pressure and the general characteristics just
referred to, there are many who seek the advice of a physician
because of some troublesome subjective disturbance, the re-
sult of their hypertension. The early symptoms may vary
considerably. It is usually stated that headache is one of the
earliest symptoms; this was especially emphasized by Jane-
way[69] who states that these headaches due to hypertension,
are particularly frequent in the early morning hours, and have
a tendency to recur over considerable periods of time. In the
writer's experience, although headache is an exceedingly com-
mon early symptom of hypertension, it is not complained of
as frequently as is slight shortness of breath on exertion, often
associated with palpitation and an uncomfortable throbbing of
the vessels of the head and neck. Vertigo and tinnitus aurium
frequently accompany the headache of hypertension.

Gastrointestinal symptoms are not uncommon as early mani-
festations of this condition. In people of middle age, the
vague gastrointestinal symptoms for which there is no ob-
vious cause, should never be dismissed until the possibility of
their being due to or associated with hypertension has been
eliminated. Epigastric distress, fullness after meals, eructa-
tions of gas, and general abdominal disturbances are among
the more common digestive symptoms noted.

Other early symptoms of hypertension are undue mental and
physical fatigue, following ordinary amounts of work or ex-
ercise. The first indications of too high a blood-pressure may
be epistaxis, and at times the first intimation of the disease
comes with a retinal or subconjunctival hemorrhage.

An onset of this latter type, in a patient otherwise con-
spicuously free of symptoms, is illustrated by the following
case. A woman aged sixty-two years who had always enjoyed
extraordinarily good health, and had led an active life en-
tirely free of symptoms suddenly noticed disturbances of

vision in the right eye. The ophthalmological examination showed that this impairment of vision was due to a retinal hemorrhage. The patient was so free of symptoms that it was with difficulty that she was made to believe there was any disturbance in.her circulation. Examination showed her to be a well developed and over nourished woman. Her systolic blood-pressure was 210, diastolic 120. There was definite hypertrophy of the left ventricle. Repeated urinary examinations were negative, functional tests of the kidneys showed that the phthalein was eliminated normally. Chemical examination of the blood showed that there was no accumulation of urea nitrogen or other retention products. Her Wassermann was negative. An essential hypertension that had evidently existed for a number of years without symptoms, was the only discoverable cause of her trouble.

From what has been said it may be inferred that a motley and varied array of symptoms indicate the early stages of essential hypertension. This fact adds materially to the difficulty of early diagnosis, especially as these symptoms frequently are not directly referable to the cardio-vascular system. The more widespread employment of routine blood-pressure determinations, has done much to increase the frequency and accuracy of the diagnosis of essential hypertension. Formerly many cases were looked upon as instances of "biliousness" or "neurasthenia" until the final progress of the disease revealed their true nature. The importance of recognizing these cases of hypertension early is evident when it is realized that the successful management of the condition is only possible during the early stages before the secondary changes take place in the various organs.

When essential hypertension has existed for any length of time, changes of a secondary nature begin to develop in the various organs, notably in the heart and kidneys. As a rule, by the time patients put themselves under the care of a physician, anatomical changes have already involved these organs, and symptoms and signs referable to them are usually demonstrable.

The heart is the organ which from the start has to bear the brunt of the increased peripheral spasm underlying the hypertension, and from the first shows the evidence of the increased

demands made upon it by hypertrophy of the left ventricle, the chamber primarily and chiefly involved. In Janeway's series[69] slightly over seventy-five per cent. of his cases of hypertension showed demonstrable cardiac hypertrophy. In a series studied by the writer, from which so far as it was possible all cases that had an underlying renal basis were excluded, hypertrophy of the heart as shown by physical examinations, was present in eighty-one per cent.

Cardiac changes constitute the most conspicuous physical findings in essential hypertension. By inspection and palpation, the apex beat is found displaced downward and to the left. It is often heaving and forcible in character. This cardiac overactivity, especially noticeable after exertion, constitutes one of the most unpleasant subjective symptoms of the disease. The left border of cardiac dullness is found a variable distance to the left. As a rule there is no noteworthy upward or right sided increase in cardiac dullness, indicating that hypertrophy is largely limited to the left ventricle. At the apex beat the heart sounds are loud and snappy. In the course of time when myocardial degeneration supervenes, it is not unusual to have the first sound of the heart replaced partly by a soft, systolic apical murmur, the result of overstretching of the mitral ring. From the first, at the aortic area, a ringing accentuated second sound is almost invariably heard. A short systolic aortic murmur, more marked after exertion and frequently transmitted up into the vessels of the neck, is a common occurrence.

Such a murmur is not indicative of disease of the aortic valve so much as of changes in the aorta itself. In many instances it is the result of beginning atheromatous changes in the aorta, a chronic aortitis. Frequently it is associated with a moderate degree of dilatation of the aortic arch. The frequency with which some dilatation of the aorta is associated with essential hypertension is not generally appreciated. In the writer's series, fifteen and three-tenths per cent. of the cases of essential hypertension showed dilatation of the aortic arch as demonstrated by dullness in the first and second interspaces to the right of the sternum, and an increased pulsation in the suprasternal notch. X-ray examination of the chest in cases of this kind, frequently reveals dilatation of the

aorta which is not demonstrable by ordinary means of physical examination.

Cardiac irregularities not infrequently occur in connection with the cardiac changes characteristic of hypertension. The most common form of irregularity observed is a premature ventricular contraction.   Paroxysmal tachycardia also is observed occasionally.

Cardiac hypertrophy is evidently compensatory in nature and so long as the integrity of the heart muscle is maintained, patients suffer very little subjective discomfort in spite of their hypertension, except at times from precordial oppression and palpitation, more marked after exertion, and from throbbing of the larger vessels.   When, however, for any reason the nutrition of the heart muscle begins to be impaired, symptoms of beginning cardiac failure supervene.   Too often it happens that these are the symptoms that first attract the attention of physician or patient.   One of the first symptoms of cardiac failure is shortness of breath, at first noticeable only upon exertion and later becoming more marked. When dyspnea becomes a rather prominent symptom, it is not unusual to find at the bases of the lungs crepitant râles, the result of pulmonary edema which varies in intensity from time to time.

At times attacks of paroxysmal pulmonary edema occur in these cases of essential hypertension.   The phenomenon is more common, however, in those cases of hypertension that are secondary to chronic nephritis.   The whole question of pulmonary edema as it relates to cardiac hypertrophy and vascular changes, has been ably discussed by Riesman,[71] and by Stengel.[72]   Cardiac, renal or arterial disease attended with high blood-pressure, seems to be chiefly responsible for this type of acute pulmonary edema, which is induced by increasing myocardial weakness associated with a rise in blood-pressure.

It is interesting to observe that the attacks of acute pulmonary edema that occur in the course of hypertension are quite different in their clinical manifestations, as well as in their mode of production, from the congestion and edema of the lungs that result from failure of the right heart in cases of chronic cardiac dilatation.   The most satisfactory explanation of this acute general edema of the lungs, was that offered

by William H. Welch in 1878, based upon the admirable
experiments which he conducted in Cohnheim's laboratory
at Breslau.[73]   Welch's explanation, stated in his own words,
is that such acute pulmonary edema is due to "a dispro-
portion between the working power of the left ventricle and of
the right ventricle, of such character that the resistance re-
maining the same, the left heart is unable to expel in a unit
of time, the same quantity of blood as the right one."   Accord-
ing to Melzer, the same theory probably explains the occurrence
of edema of the lungs in experimental animals after the in-
jection of adrenalin.

A typical example of recurrent attacks of acute pulmonary
edema in the course of essential hypertension, is furnished by
a case long under the observation of the writer.   A nervous
and exceedingly energetic woman developed a marked degree
of hypertension at the age of thirty-five.   Her systolic blood-
pressure averaged 260 millimeters of mercury, diastolic 140.
Repeated renal studies failed to show kidney involvement.   All
possible foci of infection were removed.   The hypertension
continued, and she was regarded as a case of essential hyper-
tension, possibly due to some endocrine disturbance.   When
she first came under observation, the hypertension was already
associated with marked cardiac hypertrophy.   In spite of every
effort it proved impossible to reduce this patient's blood-pres-
sure, and whenever she over-exerted herself in the slightest,
her already high pressure would reach an excessive height.
It was not infrequent to observe her systolic pressure up to
300 millimeters of mercury and the diastolic between 150 and
160 millimeters.   About five years after she first came under
observation, it was noticed that during the times when she ex-
perienced these elevations of pressure, both lungs would be
filled with fine crepitant râles more marked at the bases.   After
a period of rest the blood-pressure would become lower and
the râles would disappear.   These periods of high pressure
associated with pulmonary edema were finally associated with
an urgent dyspnea, cough and the expectoration of frothy al-
buminous material.   At no time were the attacks associated
with any evidence of dilatation of the right heart.   Aside from
these attacks of pulmonary edema, this patient never experi-
enced any other evidence of myocardial weakness.   Even with

her excessive blood-pressure she lived for twelve years after first coming under observation, and finally succumbed to a cerebral hemorrhage.

Another evidence of beginning cardiac failure is the occurrence of edema. This edema is at first slight, makes its appearance about the ankles, and like other forms of edema of cardiac origin, is observed at the close of the day and disappears while the patient is recumbent during the night. It sometimes happens that the occurrence of slight edema about the ankles is the first symptom that attracts the patient's attention to any circulatory disturbance.

Cardiac pain at times heralds the onset of myocardial degeneration. In a series of hypertension cases studied by the writer, cardiac pain was more common in those patients in whom there was a renal basis for hypertension, than in those with primary or essential hypertension. Nevertheless, in this other group, seventeen and five-tenths per cent. suffered at one time or another from angina or angina-like pain. Such pains were observed more frequently after exertion, excitement, undue fatigue or over-eating. In the early stages of essential hypertension, although the cardiac pain is a significant evidence of cardiac overstrain, it is often of no serious import, but in cases of hypertension that have existed for some time, and in whom changes in the aorta, coronary arteries and myocardium have occurred, angina-like pains are always of serious significance. Personal observation suggests, however, that angina pectoris is not a common cause of death in essential hypertension.

As a case of essential hypertension progresses, evidences of myocardial failure become more and more marked until gradually the well-known symptoms of chronic cardiac failure supervene. Not infrequently the error is made of looking upon symptoms of heart failure as symptoms of hypertension. In no sense can these be regarded as such. They are but the final stage in a sequence of events that had its inception in arteriolar spasm, that should be recognized early and combatted during that period if cardiac strain is to be averted. Mention may here be made of the fact that in spite of progressive myocardial failure, it is rare to observe any noteworthy lowering of the blood-pressure in these cases of essential hypertension.

In addition to changes that occur in the heart in essential hypertension, symptoms occur that are referable to the blood-vessels themselves. The peripheral vessels, such as the radials and the temporals, are distinctly palpable and feel tense and resistant to the fingers, but they do not exhibit the tortuosity, beading, and thickening observed after true degenerative changes have taken place in the vessel walls. For a similar reason the obstructive phenomena so often observed in visceral and peripheral vessels in well established arteriosclerosis can hardly be said to belong to essential hypertension. Neverthe-less, circulatory disturbances of a transient nature are occa-sionally observed, particularly in certain groups of vessels. In-dividuals with primary hypertension may complain from time to time of paroxysms of pain, parasthesia, numbness, tingling and weakness in the extremities. These symptoms may be as-sociated with, or followed by, the so-called dead fingers and toes in which one or more of these extremities become tem-porarily blanched, cold and numb. Often allied conditions, such as erythromelalgia and Reynaud's disease, may also be observed in connection with cases of essential hypertension. The paroxysmal nature of these peripheral phenomena lends considerable weight to the theory advanced by Pal,[74] and by Osler,[75] that they are due to vascular spasm of vasomotor origin. Allbutt[76] is disinclined to accept this explanation and believes that this theory is not supported by the available evidence.

Local vaso-constriction may also take place in the cerebral vessels, giving rise to transient aphasia, palsies, or weakness of short duration involving various muscle groups, usually of the extremities or even one entire side of the body. Allbutt is most emphatic in his refusal to attribute these temporary cerebral symptoms to vascular spasm, and has advanced rather convincing pathological proof that they are in reality due to minute hemorrhages or thromboses involving the cerebral arterioles. He is vigorously opposed to Osler's[77] statement that arteries which are sclerotic or are becoming so, are ab-normally sensitive to vasomotor cramps. The truth may lie somewhere between these theories, and Mosenthal[78] may be nearer right when he states that these transient nervous phenomena occurring in the course of hypertension cannot be

explained exclusively on either of these bases, and that prob-
ably spasm as well as hemorrhage may occur.

These transient paralyses, sensory disturbances, aphasias
and confusional states, observed in cases of essential hyper-
tension, are extremely fleeting, last but a few minutes, as a
rule, and rarely more than a few hours, and show a decided
tendency to recur. In most instances they are but a fore-
runner of more serious vascular lesions of the central nervous
system, but so long as a case remains one of uncomplicated
hypertension, they are rarely of serious consequence. Ac-
cording to some authors these transient paralyses are not
uncommon in essential hypertension. In a series of hyper-
tension cases from all causes including renal disease, analyzed
by the writer, transient paralyses were observed in 10.6 per
cent. of cases, but in a smaller group of true primary essential
hypertension patients, these nervous phenomena were dis-
tinctly uncommon and occurred in only 0.67 per cent.

Other vascular phenomena of frequent occurrence in essen-
tial hypertension, are epistaxis, often severe and frequently
followed by noteworthy relief of symptoms such as headache.
In some conjunctival hemorrhages are common, and although
not serious in themselves, are of diagnostic importance and
often suggest the possibility of hypertension that has been
previously unsuspected. Retinal hemorrhages are among the
most common, frequent and often serious vascular phenomena
observed in this condition.

Sooner or later in most cases of hypertension, renal symp-
toms develop. Early in the condition there is usually a con-
spicuous absence of any definite renal involvement. This fact,
now amply confirmed by many observers, may be taken as
evidence that essential hypertension is primarily a general cir-
culatory disturbance, which develops independently of any
renal disorder .

One of the earliest symptoms suggesting secondary kidney
change in the course of essential hypertension, is moderate
nocturnal polyuria. This was particularly emphasized by Jane-
way.[79] Early in the condition faint traces of albumin and
occasionally hyaline casts inconstantly make their appearance.
It is characteristic of essential hypertension, that evidences of
impaired kidney function are lacking. There is no fixation of

the specific gravity, which when two hourly tests are carried out, shows normal variation. Stengel has pointed out a tendency to a marked morning and evening difference in the specific gravity. Active secretion of the urine usually follows water drinking. Renal function, as estimated by the phenolsulphonephthalein test is normal and not infrequently the kidneys seem particularly permeable to the dye which is eliminated in unusually large quantities. Examination of the blood for accumulation products such as urea nitrogen, uric acid and creatin, gives normal values.

After essential hypertension has existed for some time, the vascular changes which progressively take place in the kidneys gradually impair more and more the renal function. It is uncommon for a case of essential hypertension to succumb to renal insufficiency, unless by chance some chronic renal disease is engrafted upon the benign renal sclerosis. On the other hand, in the final stages of essential hypertension, urinary changes may be so marked and renal function so impaired, as to make it impossible at times to determine whether a case is one of primary renal disease with secondary vascular changes, or a case which is fundamentally vascular with secondary kidney involvement. The clinical picture may be further confused by the presence of chronic passive congestion of the kidney secondary to a terminal myocardial failure.

The changes in the blood in essential hypertension are not significant. In the writer's series, moderate secondary anemia was encountered frequently, but it is doubtful whether such changes were not more often the result of some intercurrent or associated condition rather than the vascular disturbance.

Various digestive symptoms as possible early evidence of hyperpiesis have already been referred to. This phase of the subject has been taken up by Riesman.[62] Later in the disease, various gastrointestinal symptoms are encountered, but here again it is questionable whether these symptoms are so much the result of the hypertension as they are of some coincidental condition. In the writer's experience, abdominal symptoms frequently complained of by middle-aged women with essential hypertension, are more often due to chronic cholecystitis, with or without gall-stones, and the gastrointestinal disturbances frequently associated with these gall-bladder infec-

tions, than to the vascular disease itself. When myocardial weakness supervenes in the course of essential hypertension, a great many gastrointestinal and abdominal symptoms occur which are the result of the chronic passive congestion incident to the failing heart. Great care must be exercised not to attribute all the various symptoms that may be complained of by a patient to vascular disease just because a persistently elevated blood-pressure is encountered. A tendency to forget that several disease conditions may coexist in the same individual and a readiness to explain all symptoms on the basis of a single, easily recognized abnormality, is often responsible for much diagnostic confusion.

DIAGNOSIS OF ESSENTIAL HYPERTENSION.

The essential feature in the diagnosis of primary hypertension is to recognize by some precise method, the presence of a persistent elevation of both the systolic and diastolic pressures. To find the blood-pressure occasionally elevated, especially when some temporary cause for such elevation exists, is not sufficient grounds for the diagnosis of essential hypertension. For that reason such a diagnosis should not be made until the blood-pressure has been found repeatedly elevated after a number of determinations have been made under varied conditions. When a persistent hypertension has been discovered, it becomes incumbent upon the observer to determine whether such elevation is but an incident in some condition such as hyperthyroidism, or is one of the vascular phenomena of aortic insufficiency. These conditions usually offer little difficulty if the age of the patient is considered and a complete history is taken in conjunction with a careful physical examination.

One of the main diagnostic problems is to decide whether the high blood-pressure can still be regarded as due only to essential primary hypertension, or whether it has already become complicated by the presence of true arteriosclerotic changes. The differentiation between a case of primary hypertension and one in which high blood-pressure is associated with arteriosclerosis depends upon the age of the patient, the probable duration of the hypertension, the existence of symptoms that point to structural changes in the various organs, and the physical findings, especially those which point to

atheroma of the aorta and thickening, beading and tortuosity of the peripheral vessels.

The most important and at the same time the most difficult diagnosis is the recognition of hypertension which is the result of primary renal disease. Although in the writer's experience hypertension occurs with equal frequency in men and women, in men hypertension is due to some form of nephritis almost twice as often as it is due to a primary vascular cause. The age of the patient is also an aid to this differential diagnosis, since hypertension in those under forty years of age is more often nephritic than vascular in origin. The history of some preceding renal disease, or of an infection that is frequently complicated by renal disease, as well as the existence of symptoms suggestive of renal insufficiency, frequently give a clue to the underlying cause of an elevated blood-pressure. The diagnosis of primary renal disease, however, must ultimately rest upon the urinary findings and functional kidney tests. These have been discussed sufficiently in the section on renal disease, and the inconstant urinary findings in the absence of definite evidence of functional renal impairment characteristic of essential hypertension have already been alluded to. Instances will be encountered, however, in which accurate determination of the underlying condition will prove impossible in view of the advanced changes that may coexist in the kidneys, blood-vessels and the heart.

PROGNOSIS OF ESSENTIAL HYPERTENSION.

In those who exhibit persistent hypertension, the underlying cause of the high pressure bears a definite relationship to the prognosis. In a series of hypertension cases studied by the writer,[80] it was found that the greatest mortality existed among those in whom the high pressure was the result of chronic nephritis. Of the nephritic hypertension cases, 55.5 per cent. terminated fatally, and about 28 per cent. died within three years of the time that they came under observation. On the other hand, only 17.6 per cent. of the cases of essential hypertension with or without arteriosclerosis, had succumbed. It is interesting to note that in this series, among the cases of primary vascular disease that died, there was not one instance of so-called menopausal hypertension. Death was three times

more frequent in nephritics than in those suffering from hyper-tension from other conditions. From the analysis of the author's material it would appear that the prognosis as to life in cases that are truly primary essential hypertension, is much better than is generally believed; in women in whom the hypertension is associated with the climacterium, the vascular changes seem in no way to modify the normal expectancy of life. A more general appreciation of this fact is of distinct practical importance, in view of the widespread belief among the laity, too often shared by physicians, that the existence of hypertension means early disaster.

The experience of the writer is in accord with the observa-tions of Janeway and others that the height of the blood-pres-sure alone is an uncertain and unreliable prognostic index. The prognosis depends upon other factors, particularly the degree of degenerative change that has taken place in the blood-vessels, the integrity of the heart muscle, and the func-tional efficiency of the kidneys. It is these secondary changes, the outcome of the hypertension, rather than the high blood-pressure itself, that may ultimately bring about the fatal ter-mination of a case of essential hypertension.

In the writer's series, the commonest causes of death in individuals that primarily suffered from essential hyperten-sion, although they later developed definite evidences of ar-teriosclerosis, were chronic cardiac dilatation, cerebral hemor-rhage and angina pectoris. No instances of death from uremia were observed in true cases of primary hypertension. One-third of the cases died of intercurrent infections or causes entirely unrelated to the hypertension. On the whole, one may conclude that the prognosis in essential hypertension depends chiefly upon the functional efficiency of the various organs, notably the heart. So long as the heart muscle remains efficient, in spite of the overwork to which it is subjected, patients of this class may go on for years provided they live with reasonable care. The one possibility, however, which must never be lost sight of, and can rarely be foretold, is cerebral hemorrhage, since it is impossible to estimate the degree of degeneration taking place in the blood-vessels of the brain, which frequently are the seat of marked change even when there is no demonstrable evidence of arterio-sclerosis elsewhere.

SYMPTOMATOLOGY OF ARTERIOSCLEROSIS.

In the preceding section essential hypertension, or hyperpie-
sia, has been dealt with as a clinical entity, which usually pre-
cedes, but is almost always sooner or later associated with the
structural changes in the vessel walls recognized as arterio-
sclerosis. It is admittedly difficult to say just when in the
course of the vascular spasm peculiar to the early stages of
hyperpiesia the anatomical changes characteristic of arterio-
sclerosis take place in the vessel walls. The two conditions
merge imperceptibly one with the other. Therefore, much
that has been said in reference to the symptoms of essential
hypertension is equally applicable to arteriosclerosis, when
that condition is associated with an elevated blood-pressure.
The same difficulty, however, does not exist in the arterio-
sclerosis that has been termed senile, which is part of the
involutionary processes of advancing years and which fre-
quently develops independently of and runs its course free
from any noteworthy increase in the blood-pressure.

Essential hypertension and its sequel, arteriosclerosis as-
sociated with high blood-pressure, are the types of vascular
disease most often met with in middle-aged people, therefore,
for the present purpose they are of the greatest interest and
importance. On the other hand, it is impossible to disregard
the symptoms peculiar to the involutionary or senile form of
arterial degeneration, since precocious instances of this type
of the disease are encountered not infrequently in early
middle-age.

By the time arteriosclerotic changes take place in the ves-
sels definite symptoms as a rule are manifest. There are in-
stances, however, in which individuals live to a ripe old age
without exhibiting symptoms in spite of evident arterioscle-
rotic changes at least in the peripheral vessels. Instances of
this sort are usually found among those who suffer from the
senile form of arteriosclerosis and whose blood-pressures are
normal.

The symptoms of arteriosclerosis result from functional dis-
turbances and organic changes in various organs because of
interference in their blood supply, brought about by the
thickening, narrowing and often obstruction of the vessels that

supply them.   Such arteriosclerotic changes rarely occur with equal intensity in all parts of the body; all organs are not involved to the same degree and the process may be a purely local one limited to a single organ or part of the body.   There are no symptoms common to all cases of arteriosclerosis, therefore a discussion of the symptomatology of arteriosclerosis is simplified by considering the symptoms under the head of the various organs most frequently and conspicuously involved.

Symptoms and Signs Referable to the Heart.   When arteriosclerosis accompanies or follows hypertension hypertrophy of the heart with its attendant phenomena invariably occurs.   In view of what has been said in reference to this under essential hypertension, repetition seems unnecessary. When, however, arteriosclerotic changes develop in the coronary arteries or at the root of the aorta about their origin, myocardial degeneration develops earlier and is more conspicuous than when essential hypertension alone is present. When the orifices or main branches of the coronary arteries become sufficiently obstructed, diffuse degenerative changes take place in the heart muscle, usually of a fibrotic character. When the smaller branches are partially or completely occluded as the result of obliterating endarteritis or thrombosis, circumscribed areas of fibrosis result.   These areas of local degeneration are observed mostly in the wall of the left ventricle.   Extreme degrees of arteriosclerotic involvement of the coronary arteries are not uncommon in middle-aged individuals, who show little or no other evidence of arteriosclerosis.   This is especially true of syphilitics in whom as Osler[81] has pointed out attacks of angina are common because of the narrowing of the coronary orifice.   Angina pectoris is by no means limited to syphilitic subjects.

Arteriosclerosis may also damage the heart muscle by producing chronic valvular lesions.   Changes similar to those observed in the aorta occur particularly in the leaflets of the aortic valve, giving rise usually to a combination of aortic insufficiency and stenosis, although either of these conditions may exist separately.   Mitral insufficiency may also result from similar sclerotic changes in the mitral valve, but this is much less common than the aortic involvement.   When these

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endocardial lesions have developed they are attended by the physical signs and symptoms characteristic of them, which are discussed in detail in the section devoted to diseases of the heart. Whether arteriosclerosis produces valvular disease or coronary involvement, the ultimate outcome, so far as the heart is concerned, is the same. Sooner or later myocardial degeneration occurs followed by acute or chronic cardiac dilatation. Cyanosis, dyspnea, edema, congestion of the lungs, effusions into the serous cavities, chronic passive congestion of the solid organs, chronic catarrhal inflammations of the mucous membranes supervene and obscure the picture of the underlying primary arterial disease.

Various forms of arrhythmia result from myocardial degeneration secondary to arteriosclerosis. Premature contractions of ventricular or auricular origin, are not infrequently observed. Pulsus alternans and varying grades of heart block may also occur. In the later stages of myocardial degeneration, when decompensation occurs, auricular fibrillation and flutter may develop.

A patient long under the observation of the writer well illustrates the ultimate cardiac changes that may occur in arteriosclerosis. The patient was a well nourished man in the early sixties. He had been an excessive eater and lived under high tension for many years. About two years before his death he began to have attacks of angina pectoris and moderate elevation of his blood-pressure. Six weeks before he finally succumbed to cardiac failure he had an unusually severe attack of angina pectoris, following this auricular flutter developed which at the end of four hours became fibrillation. During the three weeks preceding his death, several minor attacks of angina occurred, each of which was followed by flutter which changed into auricular fibrillation, in which condition he finally succumbed.

Cases of true senile arteriosclerosis are noteworthy for the fact that they are not accompanied by cardiac hypertrophy. This has been emphasized as an important point of differentiation between arteriosclerosis with high tension and the involutionary form. It has been contended by some, that the low blood-pressure observed in the senile form of arteriosclerosis is the result of myocardial weakness; such, however, is

not generally the case since patients of this type will live for many years without evidences of cardiac incompetency and physical examination shows their heart sounds to be surprisingly good. Ultimately in these cases of senile sclerosis, myocardial degeneration may supervene if the arterial lesions produce narrowing and occlusion of the coronary vessels.

Moderate diffuse dilatation of the aorta was referred to under essential hypertension. When, however, true arteriosclerotic changes take place in the arch of the aorta, more permanent and more marked dilatation is likely to occur. When these dilatations are circumscribed or when the diffuse dilatations are of sufficient size, they must be looked upon as aneurisms, but in many cases of arteriosclerosis, especially in middle-aged people, moderate degrees of diffuse dilatation of the aorta occur which can hardly be placed in this category. The commonest cause for such changes in the aortic arch is a meso-aortitis of luetic origin. They do occur, however, in those who are not luetic and even in senile arteriosclerosis considerable tortuosity and widening of the aortic arch is frequently encountered. The condition may be recognized on ordinary physical examination by the increased pulsation in the supra-sternal notch, dullness under the first part of the sternum, and in the first and second interspaces to the right and left of the sternum, as well as by a systolic murmur commonly heard over the aorta and transmitted into the vessels of the neck. This manifestation of aortic arteriosclerosis is frequently associated with sclerotic changes in the aortic valve.

Renal Symptoms. When arteriosclerosis involves the renal blood-vessels, alterations take place in the kidneys which are both clinically and pathologically different from those observed in essential hypertension. The pathological changes of the arteriosclerotic or senile kidney already have been referred to. These kidney changes are practically limited to the senile form of arteriosclerosis, and when they occur, there is usually some elevation of the blood-pressure observed, although the excessively high blood-pressure so common to chronic nephritis and essential hypertension, is lacking. At times the blood-pressure may be actually low, but as a rule systolic pressures from one hundered and sixty to one hundred

and seventy millimeters of mercury are found. The urine contains small quantities of albumin, and a moderate number of hyaline and granular casts are seen with fair regularity. As the condition progresses, these become more constant, there is a distinct tendency to polyuria, particularly at night, and the specific gravity is moderately fixed at a point usually lower than normal, although the low fixation is less conspicuous than in a true chronic intestinal nephritis. As a rule elimination of 'phthalein is moderately reduced and there is some elevation or increase in the blood urea nitrogen. The creatinin is normal and the blood chlorides are not increased. In the arteriosclerotic kidney there is not the progressive diminution of function so noticeable in the chronic nephritic. Although the condition may go on for years, these patients rarely die of uremia, and in the late stages myocardial failure may supervene. Just as in the case of essential hypertension, it is often next to impossible in the late stages to differentiate between this renal sclerosis of vascular origin and a true nephritis.

Arteriosclerosis of the Central Nervous System. Changes in the central nervous system due to arteriosclerosis are of frequent occurrence and may be among the earliest observed. They may occur when there are few if any manifestations of disease elsewhere. Among the earliest manifestations of cerebral arteriosclerosis, must be mentioned a group of symptoms, expressions of fatigue, that have been included under the indefinite term of neurasthenia. Early and marked mental fatigue, irritability, inability to concentrate, and loss of memory are among the symptoms that may be grouped in this category. When they occur, especially in middle-aged individuals, without other evidences of arteriosclerosis, it may be both difficult and unjustifiable to attribute them to vascular changes in the central nervous system, since they are common to many conditions other than arteriosclerosis. In older individuals, and in those who exhibit other manifestations of arteriosclerosis, there is more justification for attributing this group of symptoms to vascular changes.

Other minor symptoms, frequently associated with and doubtless often due to arteriosclerosis of the brain, are headache, dizziness, and ringing in the ears. As has been pointed

out by Allbutt, Stengel and others, although these symptoms frequently result from changes in the cerebral circulation, they are by no means characteristic of arteriosclerosis, and in many instances are erroneously attributed' to vascular disease when they are in reality the outcome of some associated condition. By many, headache, especially one that is occipital in its distribution and which occurs in the early morning, is held to be characteristic of arteriosclerosis. In the writer's series, headache was neither frequent nor characteristic in its occurrence. Headache of vascular origin appeared to be more common in those cases of arteriosclerosis that were associated with hypertension, than in those that were purely senile in their origin. Tinnitus aurium and vertigo at times may result from local vascular lesions, but it should not be forgotten that they frequently are due to associated extra-vascular conditions, even in those with well marked arteriosclerosis.

In recent years the writer has observed several instances in which individuals with evidences of arteriosclerosis developed severe attacks of vertigo, which were promptly and permanently relieved by the removal of focal infections about the mouth, throat or accessory sinuses. On the other hand, a patient was observed who, while in apparent good health, developed a sudden and severe attack of vertigo. No local condition could be discovered to account for this disturbance. It gradually subsided in the course of a couple of days, but following this initial outbreak, there were several minor attacks of vertigo, during one of which, three months later, definite cerebral thrombosis occurred. In some instances at least, there seems to be no doubt but that vertigo of varied grades, may result from minute thromboses or hemorrhages in the cerebral vessels. The severer grades of vertigo are said to be characteristic of cerebral arteriosclerosis of luetic origin.

The most serious manifestations of cerebral arteriosclerosis are the thromboses and hemorrhages that are of such frequent occurrence. Cerebral hemorrhage may at times complicate essential hypertension, but in the writer's experience, it is of much more common occurrence when true degenerative vascular lesions supervene in the course of hyperpiesis. Cerebral hemorrhage is rare in the cases of arteriosclerosis that are unaccompanied by high pressure. The transient paralyses

referred to under essential hypertension and held by Pal, Osler and others to be due to vascular spasm may also occur in those who exhibit true arteriosclerotic changes. Cerebral hemorrhages due to rupture of arteriosclerotic vessels, may vary widely in their size and distribution. All degrees are encountered from minute hemorrhages in which a limited area of the brain only is involved, as for example in those instances where an aphasia or loss of power in one limb are the only evidence, up to overwhelming cerebral insults that result in complete loss of consciousness, wide spread paralyses, and a rapidly fatal termination. When arteriosclerosis is considered from the standpoint of middle life these cerebral hemorrhages are of the utmost importance, since they represent one of the most disastrous and uncontrollable results of the disease; prone to occur in those who are vigorous and able bodied in whom persistent high pressure has led to vascular degeneration.

Thrombosis of the cerebral vessels, however, is encountered less frequently in the middle aged and is more common in older individuals whose arteriosclerotic changes are the result of the involutionary processes of age. The occurrence of intracranial hemorrhage in one, and of cerebral thrombosis in the other, must be looked upon as one of the distinguishing features of arteriosclerosis associated with high tension on the one hand and the senile or involutionary form on the other.

Other manifestations of cerebral arteriosclerosis are convulsions, the result of obstructed cerebral circulation. Several cases of this character have been reported by Stengel,[60] who believes it is established that sudden interference with the circulation of the brain, as the result of either thrombosis, embolism or possibly vasomotor spasm, may bring about definite convulsive attacks.

The cerebral changes found in senile arteriosclerosis are rarely met with in middle-aged individuals, although at times they may be encountered in those who develop prematurely involutionary vascular changes. Under such conditions the symptoms that arise are the result of gradual occlusion of the circulation in various parts of the brain, either the result of an obliterating endarteritis, the development of a thrombus, or the occurrence of an embolism, frequently the result of atheromatous material being swept forward in the circulation. The

symptoms due to such occlusion come on gradually and are rarely associated with loss of consciousness.   Aphasias and paralyses occur, varying in extent with the amount of cerebral tissue involved, but as a rule they are more variable and less persistent than the injuries that result from cerebral hemor- rhages. The circulation of the brain makes an effort to adjust itself to these obstructions, therefore, there is a tendency for them to clear up partially, but recovery is rarely complete and the individual is left with more or less permanent motor or sensory impairment.

A certain amount of loss of mental power and psychic disturb- ance are the rule following hemorrhage or obstructive vascular lesions of the brain.   Even though motor function returns, some degree of mental impairment almost invariably persists. Following cerebral hemorrhage it is not uncommon to observe radical alterations in the mentality and disposition.   The in- dividual may exhibit some mental characteristics diametrically opposite to those that existed prior to the cerebral insult. Those who were amiable, kind and thoughtful, may become irritable, quick tempered and selfish.   Mental deterioration invariably follows in the wake of cerebral lesions. The degree of such change is in direct proportion to the extent of the cerebral injury.   A tendency to worry unduly over trivial matters, periods of great depression amounting at times to melancholia, disregard of the niceties of life, indifference to personal appearance and cleanliness, and an inability to reason or exercise judgment are among the commoner changes en- countered as the result of vascular disturbances of the brain.

In senile cases in whom areas of softening and degeneration occur as the result of occluded vessels, these mental changes are often most insidious in their onset. The progress of the mental deterioration is almost imperceptible from day to day ; but it goes forward surely and inevitably until ultimately a profound psychic alteration has occurred.   In the beginning only certain minor changes, as loss of memory, slight diffi- culty in speech, unusual irritability or unaccustomed obstinacy may be noted, but as deterioration progresses, complete and hopeless dementia may ultimately result.   The progressive mental weakness may be punctuated by attacks of mental con- fusion and excitement.

As the result of disturbance of the cerebral circulation, especially in the aged, Stengel[60] has called attention to recurring attacks of stupor and semi-coma lasting for a few hours, or even days, and alternating with periods of undue mental alertness. Such marked grades of mental impairment are uncommon in the arteriosclerosis of middle life. When they do occur during middle age, they are probably more often due to toxemias, such as uremia, than to arteriosclerosis of the brain.

In those who are suffering from the senile form of arteriosclerosis, it is frequent to observe marked weakness of the extremities, particularly of the legs, as the result of which their station is uncertain. They totter, especially when arising from a sitting position, and develop the characteristic unsteady, shuffling gait. The knee-jerk in cases of this type is usually diminished or lost. These changes may be observed even when there are no manifestations of mental deterioration, they occur without evidences of neuritis or peripheral vascular lesions, and are the result of arteriosclerotic changes in the spinal cord. The characteristic apathetic vacuous expression of the face is also met with in patients of this type. Although occasionally observed, such symptoms are distinctly unusual in middle aged individuals who as a rule, in spite of their high blood-pressure and its attendant arteriosclerosis, exhibit a considerable degree of mental and bodily vigor, until such time as a sudden destructive lesion of the central nervous system may supervene.

One of the commonest manifestations of syphilis of the central nervous system is endarteritis and such changes are particularly common in middle life. When lues is the etiological factor in cerebral arteriosclerosis, the manifestations may not differ from those observed in the non-syphilitic cases of sclerosis. On the other hand, the cerebral manifestations peculiar to syphilis that have been dealt with more appropriately under diseases of the nervous system, may occur.

Drowsiness and insomnia are two conspicuous symptoms that result from arteriosclerosis of the brain. These symptoms may be observed in all types of arteriosclerosis. Insomnia is by far the more troublesome. It is particularly evident in the early morning hours, and may reach such extremes as to seriously impair the general nutrition of the suf-

ferer. The tendency to awaken early, so common in elderly individuals, is markedly accentuated by cerebral arteriosclerosis and in some instances may actually amount to nocturnal excitement at times associated with mild delusions. Drowsiness, on the other hand, observed in arteriosclerotics, unhappily rarely occurs at night. Drowsiness may become so uncontrollable during the day, that it overwhelms the individual even when busily occupied. It is extremely common to observe this symptom following meals. In some instances the somnolence attributed to arteriosclerosis is the result of secondary renal involvement and mild uremia. But drowsiness unquestionably occurs in some solely as the outcome of vascular disease without evidence of renal insufficiency.

The writer has under observation a man in late middle life, whose earliest evidence of arteriosclerosis was early morning wakefulness; subsequently he developed a marked tendency to drop to sleep whenever he attempted to read, especially after the evening meal. No matter how great his somnolence in the early evening, a few hours in bed invariably terminated in restlessness and wakefulness.

Abdominal Symptoms of Arteriosclerosis. Medical literature abounds in descriptions of various abdominal symptoms that have been attributed to arteriosclerosis. The fact that the mesenteric vessels are frequently the seat of marked arterial degeneration even when the vessels elsewhere are uninvolved, points to a reasonable pathological basis for this assumption. On the other hand, it must be admitted that all of the various abdominal symptoms observed from time to time in arteriosclerotics cannot always be attributed to the arteriosclerosis, since frequently they are the result of associated conditions. However, Pal and others have described attacks of acute abdominal pain agonizing in character, frequently simulating acute inflammatory disease of the abdomen, that are held to be the result of spasm of the abdominal vessels. Under the term of angina abdominalis paroxysms of acute abdominal pain have been described in those known to suffer from angina pectoris. Stengel has called attention to the fact that paroxysms of intense abdominal pain may occur from time to time in those with tortuous and sclerotic abdominal aortas. There seems sufficient evidence to justify the

statement that attacks of acute abdominal pain occur in the course of arteriosclerosis in which the abdominal vessels are involved. Whether or not such pains are the result of vasomotor spasm is as yet a matter for conjecture.

Hematemesis has been observed in arteriosclerosis and in some instances this symptom has been attributed directly to the vessel changes. Such bleeding may at times be the result of ulceration of the gastric mucosa, since in certain chronic gastric ulcers arteriosclerosis of the vessels at the base of the ulcer has been observed. It is far more likely, however, that such bleeding is the outcome of leakage from minute aneurysmal dilatations of the gastric vessels.

Arteriosclerosis of the pancreatic vessels has been described. It is possible that in some old people transient, slight glycosuria and other evidences of disturbed pancreatic function, may be the result of vascular degeneration.

Arteriosclerotic individuals like others, are not infrequently afflicted with various gastrointestinal symptoms which cannot be ascribed to the arteriosclerosis, but which are due to concomitant conditions. Fullness and distention after meals, eructations of gas and acid material, discomfort amounting to pain in the right hypochondriac region, sometimes in the epigastrium and in the right iliac fossa, occasionally nausea and even vomiting, as well as general abdominal distention and distress and more or less obstinate constipation, are symptoms that have been observed in many who exhibit definite arteriosclerosis. In the writer's experience, however, such symptoms as the above are more often due to associated disturbances of the stomach and liver, or to chronic disease of the gall-bladder, malformations and ptoses of the bowel, adhesions about the cecum, a redundant sigmoid or colonic stasis from various causes, than to the vascular disease. It is common experience to have arteriosclerotic patients seek the advice of a physician for gastrointestinal symptoms, that in all likelihood bear little direct relationship to the sclerosis. Riesman[62] has pointed this out in relation to a certain type of arteriosclerotic woman. It is his impression that from one-half to two-thirds of the cases of this variety come complaining of indigestion and bloating after meals. As has already been intimated, even though a case exhibits well marked arterio-

sclerosis with or without hypertension, it is a convenient but unjustifiable practice to attribute all their symptoms to this underlying vascular disturbance.

Symptoms due to Peripheral Vessels. When the peripheral vessels are involved in the arteriosclerotic process, symptoms due to a disturbed blood supply of the limbs may be marked. Among the most interesting phenomena, the result of arteriosclerosis of the extremities, are the attacks of pain on exertion that are known as intermittent claudication. These attacks are most apt to occur in those who have demonstrable arterial thickening of the peripheral vessels. They are more common in the legs than in the upper extremities. The explanation offered for their occurrence is that the narrowed vessels although adequate for the maintenance of the circulation of resting muscles, are unable to deliver to the muscles the supply of blood required for their needs during active contraction. Since similar attacks of pain occur in those whose vessels are not demonstrably thickened, it is probable that in some instances at least, these pains are the result of vasomotor spasm. It has also been suggested that these attacks are not due to spasm of the peripheral vessels, but result from local anemia of the cord due to vasoconstriction of the spinal vessels. Intermittent claudication is as a rule, induced by exercise, such as walking. In some the pain comes on after walking but a few yards, in others it does not develop until a considerable distance has been covered. The pains usually cease as soon as the exercise that induces them is stopped. It is not infrequent to have patients state that the pains come on as soon as they begin to walk, but after they stop for a few minutes the pains disappear and exercise can then be resumed for an indefinite period without any recurrence. The pain is usually felt in the legs, and varies from a moderate degree of pain that induces a slight limp, to agonizing attacks of such severity that the patient is forced to rest before further effort is possible. The attacks of pain are usually associated with pallor of the feet. In some instances the pulse in the dorsalis pedis is not palpable. Although intermittent claudication is usually confined to the lower extremities, similar attacks may occur in other parts of the body. Ramsay Hunt[82] has called attention to intermittent claudication of the lumbar muscles. He

described individuals with well marked signs of arterio-
sclerosis who developed severe pain in the lumbar muscles
following exertion, which was promptly relieved by rest.
In one instance merely leaning against a tree or a post would
relieve the condition.

In the obliterating forms of endarteritis, at times encoun-
tered in middle-aged people, but more often seen in the senile
types of arteriosclerosis, the gradual occlusion of the circula-
tion may give rise to neuritic pain, paresthesia, numbness,
tingling and burning. In one instance of well marked arterio-
sclerosis occurring in a middle-aged man who has been under
the observation of the writer, one of the earliest signs of the
disease was numbness and paresthesia occurring in the index
finger and thumb of the right hand, followed later by a similar
development on the opposite side of the body. Intermittent
attacks of coldness and pallor of the fingers, so called "dead
fingers" are often observed in comparatively young arterio-
sclerotics and are more common in those with high pres-
sure than in others. These attacks come on intermittently and
are apparently the result of vascular spasm.

The results of complete occlusion of the vessels by gradual
obliteration of the lumen are not met with so frequently in the
middle-aged individual as in those of more advanced years.
When, however, such obstruction becomes complete, the skin
below the obstruction becomes cold and blueish, pulsations in
the palpable vessels are no longer obtainable, and finally ulcer-
ation and local gangrene result. Such conditions are observed
chiefly in the legs and feet.

Osler has called attention to the frequency with which
cramps particularly in the calf muscles, occur in older indi-
viduals. Unlike intermittent claudication, these cramps usu-
ally develop while the patient is at rest and are frequently
nocturnal. He is inclined to the belief that angiospasm is the
cause of these painful cramps. These cramps may occur with
a frequency and attain a severity that renders them most dis-
tressing. In this connection the writer can recall an over
nourished, elderly lady, with a moderate hypertension and
arteriosclerosis, in whom the nightly recurrence of severe
cramps in the calf muscles proved a serious interference to
adequate rest.

Ocular Manifestations.   Various ocular manifestations of arteriosclerosis are often observable in the vessels of the eye. As Stengel[83] has put it: "The ophthalmoscope may reveal the positive evidences of vascular disease before the disease arteriosclerosis has become marked." It is for this reason that the ophthalmologist is often the first to recognize the existence of unsuspected arteriosclerosis, and in many middle aged individuals the first hint of on-coming vascular degeneration is given by the ophthalmoscope. Although angiospasm of the retinal vessels may exist without similar changes occurring elsewhere and conversely the eye grounds may be essentially normal even when wide spread arteriosclerosis is present, nevertheless, the finding of definite evidences of arteriosclerosis in the retinal vessels must always be regarded as important evidence that arterial changes are taking place elsewhere in the body.

G. E. de Schweinitz[84] finds it convenient to divide the retinal lesions that are indicative of arteriosclerosis, particularly when that condition is associated with high pressure, into those that are suggestive and those that are pathognomonic. In discussing these lesions it would be difficult to improve upon that author's description, therefore the liberty is taken of quoting in part from de Schweinitz's paper.

"The suggestive signs include uneven caliber and undue tortuosity of the retinal arteries, increased distinctness of the central light streak, an unusually light color of the breadth of the artery and alteration of the course and caliber of the vein.

"The pathognomic signs include changes in the size and breadth of the retinal arteries of such character that a beaded appearance is produced; distinct loss of translucence; decided lesions in the arterial walls consisting of light stripes in the form of perivasculitis; alternate contractions and dilatations of the veins; and particularly, and this is the most important of the signs, indentation of the veins by the stiffened arteries . . . Sometimes the veins are flattened slightly at the point of crossing or merely pushed aside. The caliber is contracted, so that beyond the point of crossing there is an ampulliform dilatation. In addition to these well known signs, there may be changes in the venous walls, so that they are bordered with white stripes, and the veins may be distinctly tortuous and

contain varicosities. Finally, there are edema of the retina in the form of opacities around the disk, or following the course of the vessels, hemorrhages manifest themselves as linear extravasations around these infiltrations, sometimes assuming a drop like form."

In discussing the earliest indication of arteriosclerotic lesions in the retina, de Schweinitz further emphasizes: "(1) A markedly cork screw appearance of certain arterial twigs. Either those which skirt the macula or, more significantly, of one or more small branches which arise from the larger vessels of the main distribution, which themselves are apparently normal. (2) A flattening of a vein where it is in contact with an artery. The vein is only slightly compressed at this stage, but has not yet indented sufficiently to produce an ampulliform dilatation of the vein beyond the point of crossing. (3) The nerve has an appearance often loosely described as congested."

The later signs of ocular arteriosclerosis, include marked indentations of the veins with ampulliform dilatations beyond the point of pressure, varicosities, silver wire arteries, and perivasculitis and hemorrhage.

In cases of arteriosclerosis associated with high blood-pressure, the writer has been impressed with the frequency with which a retinal hemorrhage has proved the first symptom that induced the patient to seek medical aid.

The retinal changes found in arteriosclerosis are not only of diagnostic but also of prognostic import. The frequent relationship between cerebral arteriosclerosis and changes in the fundus is responsible for the observation, that in a large percentage of cases with well marked retinal changes, cerebral hemorrhage supervenes in a comparatively short time. The ophthalmoscopic evidences of retinal arteriosclerosis are also of importance in those cases of vascular disease associated with high tension that are secondary to chronic nephritis. In a series of cases of this type, studied by the writer, two-thirds of those that had definite retinal lesions, succumbed within two years after coming under observation.

The ophthalmic evidences of arteriosclerosis are here dwelt upon because in general their significance is not sufficiently appreciated. The importance of careful eye-ground examination

as an aid to the early diagnosis of arteriosclerosis cannot be too strongly urged.

General Symptoms of Arteriosclerosis. In addition to the local manifestations of arteriosclerosis, that have been discussed, certain general symptoms may be observed in most cases.

During the early stages of arteriosclerosis, especially at a time when hypertension exists with little or no actual degenerative change in the vessels, general evidences of the disease are conspicuously lacking, and the patient presents not only a good color and a good state of nutrition, but exhibits remarkable mental and bodily vigor. As the disease progresses, and anatomical changes become more and more marked in the vessel walls, general symptoms become manifest. Nutrition begins to fail and loss of weight may become a conspicuous symptom. A certain amount of pallor develops which is not due so much to anemia as it is to the contraction of the cutaneous vessels. The ordinary duties of life produce unaccustomed fatigue, and the mental powers gradually fail and physical endurance wanes. Even in middle-aged individuals the transition may be strikingly rapid from a condition of fair nutrition and vigor to one of virtual senility. When the downward progress has once begun, deterioration is rapid; even the middle-aged arteriosclerotic may soon present the general appearance so characteristic of the aged. These changes may require but a few months for their completion, and often have their inception in some worry or mental shock. Recently several instances have come under the writer's observation where well nourished, vigorous active business men, as the result of undue financial strain, deteriorated so rapidly that in the course of three or four months, they presented all the physical and mental characteristics of old men.

The subject of advanced general arteriosclerosis, particularly when the vessels of the central nervous system are involved in the process, is as a rule, poorly nourished, has a pallid and relaxed skin, is no longer erect, but stoops, walks with an unsteady shuffling gait which has lost its spring, develops a well marked arcus senilis and a vacuous expression of the face, and exhibits marked loss of muscular energy and mental vigor.

THE DIAGNOSIS OF ARTERIOSCLEROSIS.

In arriving at the diagnosis of arteriosclerosis, one should always be mindful of the fact that the process may be largely a local one, and that serious disease of the internal vessels may exist with little or no evidence of sclerosis in the peripheral circulation. Too much dependence, therefore, must not be placed upon the tortuosity and thickening of the visible and palpable vessels. Due consideration should be given to the symptoms above discussed, which indicate local disturbances of the various organs.

When the disease is general and the peripheral vessels are involved less difficulty may be encountered in making the diagnosis. Care must be exercised, however, not to mistake the full vessels so commonly observed in essential hypertension for the thickened, rigid, often tortuous and sometimes beaded arteries characteristic of true sclerotic changes in the vessel walls.

As has been alluded to before, much reliance cannot be placed upon the mere elevation of blood-pressure in the diagnosis of arteriosclerosis, since often the highest pressures are met with in essential hypertension, before noteworthy anatomical changes have taken place in the arteries, and conversely extreme grades of sclerosis, especially of the senile type, are encountered with little or no associated elevation of pressure. In this connection it should be repeated that the evidences of arterial disease of the retinal vessels furnish one of the most satisfactory and early means of recognizing the existence of arterial disease.

Except in the cases of arteriosclerosis that are associated with hypertension, the hypertrophy of the heart commonly referred to as one of the evidences of arteriosclerosis, is notably absent. Therefore, the examination of this organ may be of little avail in the diagnosis of arteriosclerosis. In the writer's experience, the signs of a low grade chronic aortitis, that is, an increased area of dullness under the first part of the sternum, a pulsation in the suprasternal notch, and a systolic murmur heard over the aorta and transmitted up into the vessels of the neck, is a useful diagnostic evidence of arteriosclerosis which is of frequent occurrence, and is found in the

involutionary form of the disease, as well as in varieties associated with high pressure.

The frequent occurrence of albumin and casts in the urine of arteriosclerotics, leads to the common error of looking upon many cases that are primarily vascular, as instances of renal disease. It is exceedingly difficult, especially in advanced cases, to differentiate between primary renal and vascular disease. From a prognostic standpoint, careful differentiation between primary vascular or renal disease is of more than academic interest. Careful and complete urinary studies, observations on the chemical compositions of the blood, and renal functional tests, all of which has been alluded to in some detail elsewhere will do much toward the differentiation between the renal scleroses that are a part of general vascular disease, and the high pressure and blood-vessel changes that are the result of a true chronic nephritis.

PROGNOSIS OF ARTERIOSCLEROSIS.

The prognosis of arteriosclerosis depends upon the type and extent of the vascular lesions. When arteriosclerosis is associated with high blood-pressure, the prognosis is distinctly less favorable than it is in those cases in which no elevation of blood-pressure exists, even though in the latter degenerative changes in the vessels are more marked and wide spread. Arteriosclerosis with high pressure usually terminates by cerebral hemorrhage, chronic dilatation of the heart, or angina pectoris. Arteriosclerotics that present lesions of the milder type that are not associated with hypertension, may live in comparative comfort for many years, and are most likely to succumb to some intercurrent infection, or myocardial degeneration.

Local involvement of various organs is also a factor of prime importance in the prognosis of arteriosclerosis. If the brain, heart or kidneys are not seriously implicated in the disease, the outlook for a reasonable duration of life is distinctly better than when any or all of these organs are the seat of definite vascular lesions. If the possibility of cerebral hemorrhage is excluded, it may be said that the prognosis of arteriosclerosis depends more upon the functional efficiency of

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the kidneys and the integrity of the myocardium, than upon any other factors. When serious cerebral lesions occur, or evidences of myocardial failure or renal insufficiency supervene, the prognosis at once becomes serious.

THE TREATMENT OF ARTERIOSCLEROSIS.

When the lesions of arteriosclerosis have once developed they cannot be removed and hence the importance of prophylactic measures to prevent the development of such changes at once becomes apparent. Since infections play such an important rôle in the production of arteriosclerosis, all measures that are useful in lessening the incidence of acute infections have an important prophylactic bearing on arterial disease. Greater care should be exercised in the management of those convalescent from the acute infections, that experience has shown are apt to leave as one of their results a vascular injury. Since syphilis is the one infection above all others that is responsible for arterial disease, particular attention should be paid not only to its prevention, but also to the thorough systematic treatment which is today possible for all those who acquire the disease. Since focal as well as general infections produce or accentuate a tendency towards arteriosclerosis, whenever such foci develop they should be promptly and thoroughly eradicated.

Other measures of prophylactic importance are the elimination from various industries of poisons such as lead, which gives rise to vascular degeneration, and the best possible management and control of those conditions in which endogenous toxins are elaborated that are responsible for arteriosclerosis, such as nephritis, diabetes, gout, chronic gastrointestinal toxemias, etc. The probable relationship in some individuals at least, that exists between vascular degeneration and over-eating, alcohol, tobacco, hard physical work, insufficient rest, and prolonged nervous strain, clearly indicates other important lines of prophylactic endeavor in the control of arteriosclerosis. To lay down fixed principles for the management of these several factors is of course futile in view of the widely varied economic and social conditions under which different individuals must exist. After arteriosclerosis has

once developed, careful management can do much at least to prevent its further progress and control or alleviate many of its most troublesome symptoms and complications.

The Management of Hypertension. In essential hypertension before noteworthy anatomical changes have taken place in the vessels, well directed treatment may be productive of much good. It is for this reason that it is particularly important that this condition be recognized early. After the diagnosis of essential hypertension has been definitely established, and it has been shown that the high pressure is not merely a symptom of primary renal disease, the first step in the treatment consists in a careful search for any probable etiological factors that may be responsible for the elevated pressure. To this end careful investigations must be carried out for any possible focus of infection, directing particular attention to the teeth, the tonsils, the accessory sinuses, the gall-bladder, the intestinal tract, the urinary bladder; in men the prostate and the seminal vesicles, and the pelvic organs in women. It is no uncommon occurrence to see cases of essential hypertension improve markedly after the removal of infected tonsils or the extraction of teeth that are the seat of apical abscesses.

The possible relationship between essential hypertension and endocrine disturbances, also requires consideration. The whole question of endocrine imbalance, is too imperfectly understood to permit as a rule very accurate deductions along this line. In the writer's experience, glandular therapy has proved disappointing in the management of cases of hypertension, with the possible exception of certain instances where the high pressure seems to be the result of the climacterium. Some cases of climacteric hypertension appear to improve under various ovarian preparations.

A search for the underlying etiology in essential hypertension more often than not reveals the fact that the patient's mode and habits of life are the responsible factors. Excessive mental strain and intellectual effort coupled with worry and responsibilities, living at too high a tension often with insufficient rest, is the usual story elicited from these patients. In some an additional cause for the high pressure is found in

over-eating, the consistent, if not the excessive use of alcohol, and possibly too much tobacco.

The readjustment of a patient's life in such a way as to eliminate the wear and tear of a modern professional or business existence, is obviously a matter of prime importance in the management of most cases of essential hypertension. However necessary such a readjustment may be, for many reasons it is often well nigh impossible to accomplish. Each case requires most careful individual consideration; there is no rule which is generally applicable, and in all cases the complete coöperation and confidence of the patient is indispensable.

In addition to making an effort to eliminate the underlying factor, it frequently becomes necessary to treat essential hypertension symptomatically. The obtrusive symptom of the condition is the high blood-pressure. Much discussion has arisen as to whether or not it is desirable to lower the high blood-pressure in cases of this character; since it is assumed by some that the hypertension is a protective mechanism, an early effort on the part of nature to maintain a circulation against increased resistance. Such an argument is perhaps more applicable to cases of high pressure that are associated with chronic nephritis, than to those that are true instances of primary hypertension, in which the underlying disturbance is arteriolar spasm, in all likelihood induced by some toxic or nervous influence. Inasmuch as a high tension frequently gives rise to troublesome and distressing symptoms, and as in the case of other protective mechanisms, the tension may become so excessive as to itself become a menace to the individual, it not infrequently becomes desirable to take measures directed towards lowering the excessive vascular tension.

The writer's experience is in accord with that of most others that the one most successful method of accomplishing this result is by complete bodily and mental rest. Nothing tends to lower blood-pressure so effectually as absolute rest in bed. If for any reason such a course is impracticable some modified form of rest treatment may be instituted, but the more the activities in which the patient is allowed to indulge, the less likelihood there is of bringing down the high pressure.

It is often astonishing to see the extraordinary drop in pressure that is brought about by a few days of rest and quiet.

Next to complete rest the most effective measure is restriction of the diet. An absolute milk diet for a few days followed by a diet of low total caloric value, more especially one in which the proteins are markedly lessened, is of great benefit. Such a restricted diet is borne well by patients that are at rest or whose activities are markedly reduced, but is unsuited to those leading active lives. It is a mistake to allow patients to follow their ordinary activities on diets of excessively low fuel value from which proteins have been almost entirely excluded. Not infrequently cases of hypertension are encountered that are suffering more from protein starvation than from their original disease, because they have been allowed to attempt active life on an insufficient diet. As a rule, however, it is true that most cases of essential hypertension in the long run do better on diets of lower caloric value than the diets to which they are accustomed; this is especially true of those that are habitually large eaters and who show a tendency to obesity. Because of the possible rôle played by the products of protein putrefaction in the intestinal tract, and the fact that the waste products of protein metabolism put an added burden on the kidneys, it is desirable that in most hypertensive cases the protein intake should be restricted. On the other hand, the rather prevalent practice of extreme dietetic reduction and the elimination of all proteins from the dietary of a case of hypertension, is usually productive of little good and may do considerable harm.

After rest, and dietetic regulations, the most useful method of reducing high pressure is active elimination. This is brought about by increased activity of the bowels, the skin and the kidneys. The patient must be impressed with the importance of having several free evacuations of the bowels daily. This does not mean, however, that each case should be plied vigorously with daily doses of saline cathartics. Individuals differ widely in the way in which they react to various cathartics, and as a rule the milder vegetable cathartics are the more desirable. Mercurials, salines and the drastic purgatives should be reserved for the occasional periods when brisk purgation is indicated.

Activity of the skin is best induced by various forms of sweating. When patients are up and about, the most effective and most pleasant sweat is the electric light bath well given under careful supervision. At the outset patients should not be kept in the bath more than ten minutes after sweating has begun and a shorter time if any undue oppression or circulatory disturbance results. Care should be taken to see that cold compresses or ice bags are kept on the head during the bath. Sweating is promoted by the free ingestion of water during the bath. After such a sweat patients should not be allowed to go out or resume their activities until they have been given an alcohol rub and made to rest for at least one hour. Such baths may be repeated several times a week, over a considerable period of time. Even though the first baths do not produce much sweating, after a number have been taken, adequate diaphoresis nearly always occurs. Similar baths may be given to patients who are confined to bed by the use of cradles of electric light or, when these are not available, by some of the older methods, such as hot packs, vapor baths, etc. These latter are more cumbersome and less effective than the newer forms of electric light baths. In many individuals effective sweating may be induced by having the patient take a very hot bath at bedtime and then go to bed wrapped up in blankets surrounded by hot water bottles. When the more elaborate forms of sweating are not available, simpler methods often have to be used. In nearly all cases of hypertension, a daily hot bath taken at bedtime, is a useful adjunct in promoting activity of the skin. All patients do not bear sweating equally well; with those in whom it induces faintness, palpitation, oppression and circulatory disturbances, it should not be insisted upon.

Increased renal output in essential hypertension may or may not be a factor of great importance, and depends largely upon the functional integrity of the kidneys. When renal elimination is defective a careful study of the renal function should be made first and, depending upon the results of such examination, the composition and quantity of the diet should be regulated. If total renal function is good and there is no undue accumulation of nitrogenous products in the blood, it is unnecessary to subject the patient to rigid restriction in the pro-

tein intake. As has already been said, such restrictions ac-
complish little and may seriously impair the general nutri-
tion of the patient as well as that of the cardiac musculature.
Of late F. M. Allen[63] and others have stressed the importance
of sodium chlorid retention in hypertension. Here again
before a patient is subjected to the discomfort and annoyance
of a salt free diet, the plasma chlorids should be estimated,
and the existence or non-existence of sodium chlorid ac-
cumulation determined. Excessive ingestion of salt indulged
in by many people, should be prohibited, but a reasonable
amount of salt may be allowed when there are no evidences
of sodium chlorid accumulation.

Probably the most effective diuretic in most cases of hy-
pertension is water. On the other hand, excessive water
drinking, too frequently advocated, is both unwise and harm-
ful. The unrestricted ingestion of huge quantities of water
puts an added burden upon a circulation that is already labor-
ing under an abnormal strain. If there is any indication of
cardiac failure, fluid intake should be reduced to not more
than one thousand cubic centimeters in twenty-four hours.
On the other hand, if the kidneys are unable to excrete con-
centrated urine, and there is evidence of renal functional
impairment, it is often necessary to increase the fluid intake.
Even then one thousand five hundred to one thousand eight
hundred cubic centimeters of water a day is usually sufficient.
It is frequently a matter for nice judgment to decide how
much fluid may be ingested without overburdening the cir-
culation on the one hand or embarrassing the renal function
on the other. Restriction of fluid should never be practiced
to the point of causing the patient discomfort and thirst. The
average case of hypertension, when the cardiac musculature
is intact and renal function unimpaired can as a rule take
with advantage, ordinary amounts of water rarely exceeding
two thousand cubic centimeters in twenty-four hours.

Diuretics, particularly the stimulating group, are rarely re-
quired to maintain the urinary output in hypertension. In-
deed there is much to be said against their use owing to the
danger of causing renal fatigue. This is particularly true of
the caffeine group which should only be used in small doses
and intermittently, if at all.

Drugs are of little value in the management of hypertension. In the writer's experience, the so-called vasodilators have rarely proved of any permanent value. The nitrites are widely employed and by some are looked upon as useful adjuncts in the reduction of a hypertension. It has become a practice with some physicians to immediately administer the nitrites in some form to every patient that presents a high pressure, and this too frequently without due regard to the etiology of the high tension, or any effort at dietetic and hygienic management. Such a practice is both unjustifiable and useless. The result obtained from the nitrites is at most temporary and fleeting. The unpleasant symptoms which they produce in many individuals when given in doses sufficiently large to bring down a high pressure, symptoms such as headache, a feeling of fullness and distention in the vessels of the head, flushing of the face, marked throbbing of the vessels of the neck and extremities are often so distressing to the patient that they offset any good that may accrue from the use of these drugs. At times the nitrites may be of signal service, as for example when it comes to relieving symptoms that are due to transient vascular spasm, such as the pain of coronary or aortic spasm, the pains that are produced by spasm of the vessels of the extremities, or even transient cerebral spasm, but their continuous use in cases of essential hypertension is as a rule unprofitable.

The iodids have always enjoyed a reputation in the management of chronic vascular disorders. They are probably more useful in cases of true arteriosclerosis than in essential hypertension, unless perchance the hypertension is associated with luetic disease of the vessels. The iodides do seem to be of value in aiding in the absorption of hemorrhages particularly those of the retina which sometimes complicate essential hypertension. Except in such instances, however, they are best not used because of their marked tendency to disturb the digestion.

Veratrum viride and aconite have been employed by some as vasodilators in an effort to lower high tension, and at times their effect is marked; as a rule, however, they are not administered in a sufficiently large dose to cause a permanent lowering of blood-pressure. The possibility of producing tox-

emia from these drugs if they are given over any length of time in doses large enough to be effective, as well as their depressing effect upon the cardiac mechanism, renders them of little value in the treatment of hypertension.

Benzol benzoate introduced to the profession by Macht, was at one time looked upon as the probable ideal harmless vaso-dilator. Shortly after its introduction some clinicians enthusi-astically advocated its use in this connection. More extended clinical experience has hardly borne out these expectations and in the experience of the writer it has not proved a success in lowering high arterial tension.

The effect of exercise on patients with essential hypertension is variable and is often a difficult problem to adjust. Many individuals upon learning that they are victims of a high blood-pressure become obsessed with the idea that exercise is likely to precipitate some disastrous complication, in consequence they abstain from all physical exertion, with the result that the normal tone of their muscles is lost and they tend to gain in weight unduly. The amount and kind of exercise that patients with hypertension may take, depends upon their age, their bodily vigor, their ordinary habits of exercise, and their individual reaction to exertion. Therefore the problem is an individual one. In general, however, it may be said that all forms of exercise that involve competition, that entail nervous strain and worry, or that require sudden physical effort, should be prohibited. On the other hand, moderate physical exercise that can be carried out without undue haste or effort such as walking, playing golf on level courses and even horseback riding, in those that are thoroughly accustomed to such exer-tion, may be indulged in with safety, and are of distinct advan-tage in most instances, since such exercise tends to increase the general muscle tone, improve the digestive tract, and equalize the circulation. Under no circumstances should any form of exercise be permitted to the point of causing bodily or mental fatigue. Simple setting up and breathing exercises taken routinely every morning on arising, often prove of dis-tinct benefit in many cases of hypertension. Some cases of hypertension derive considerable benefit from carefully given gentle massage, but it should never be severe and never persisted in if it induces fatigue or causes a poor reaction.

Climate *per se* probably has little effect upon hypertension. In general, high altitudes are best avoided by those whose blood-pressures are persistently elevated. Many cases do better at the sea level and in the warmer more equable climates. Probably the greatest good derived from a sojourn away from home in a different climate is due to the freedom from care and worry, together with the rest and relaxation that are brought about by change of environment and relief from the accustomed duties of life.

In the management of cases of essential hypertension, the fact should never be lost sight of that sooner or later as the result of the high blood-pressure, changes occur in the arteries, heart and kidneys, therefore every effort should be made to safeguard these organs from any undue strain. It is for this reason that it is often of advantage to lower if possible the high tension. As has been repeatedly said, the duration and outcome of cases of hypertension depend largely upon maintaining the integrity of the heart and kidneys, and preventing if possible, degenerative changes taking place in the vascular tree. However, if in spite of all efforts, secondary lesions of hypertension develop in these organs and evidence of their insufficiency appears; the management of such resulting conditions becomes symptomatic and differs in no way from that laid down in the chapters devoted to the various organs concerned.

All too frequently cases of hypertension come under observation not because of the symptoms of high pressure, but because of beginning cardiac failure. In this connection a word may be said in regard to the use of digitalis. The statement is frequently heard that because of the existence of high pressure, digitalis is contraindicated and that its use tends to augment further an already excessive pressure. Digitalis is capable of causing arteriolar constriction and elevation of the systolic blood-pressure, but according to the statements of Eggleston[85] there is no evidence that such an effect ever occurs clinically from any therapeutic dose of digitalis. Clinically the effect of digitalis on the blood-pressure is inconstant and the tendency is for blood-pressure to return to the normal under the use of digitalis. There are no adequate grounds for the popular prejudice against the use of digitalis in cases of

high pressure and it is the writer's belief that when cardiac failure is associated with hypertension digitalis should be used in doses sufficient to control if possible the cardiac condition. Personal experience would indicate that such a policy has never been attended with untoward results, and has frequently been the means of averting serious decompensation.

As in the treatment of most diseases, an important psychic element enters into the management of cases of essential hypertension. Every effort should be made to keep these patients from focusing their attention too much upon their bloodpressure. To this end it is advisable never to discuss with patients the question of the height of their arterial pressure, but should the matter arise it is well to impress upon them the fact that the elevated pressure is a conservative effort on the part of nature that is not necessarily incompatible with life and comfort, and that minor variations in blood-pressure are inevitable and are of no important significance. It is frequently advisable to take the blood-pressure as seldom as is consistent with the intelligent management of the case, and although it is usually necessary to acquaint some responsible member of the patient's family with the possible dangers of a persistent high tension, the greatest care should be exercised in keeping from the patient all knowledge of the catastrophes which may supervene.

The Management of Developed Arteriosclerosis. Much that has just been said concerning the treatment of essential hypertension, is equally applicable to fully developed arteriosclerosis, particularly in that form of the disease which is associated with persistent elevation of blood-pressure. In arteriosclerosis we are dealing with disease in its later stages in which anatomical changes have already taken place. The opportunity, therefore, of alleviating the condition is remote, and the best that can be hoped for is to prevent the occurrence of serious complications and sequelæ and if possible prevent the further development of the process.

Here again the first step is careful inquiry into the possible etiology of the arteriosclerosis. It may be that hypertension itself is the dominant factor in causing arterial degeneration. Then, if renal disease is the underlying cause of the hypertension, our efforts should be directed to the management of

the primary condition. If some toxin, endogenous or exogen-
ous, bacterial or inorganic, is the basis of the hypertension, the
problem is to eradicate the focus or source of the toxemia.
If primary hypertension alone is responsible, the above out-
lined plan for its management must be followed. In cases of
arteriosclerosis that are purely of senile origin, obviously
little can be done towards removing the cause, but much may
often be accomplished to prevent or at least retard, further
development of the condition.

As in essential hypertension, so in developed arteriosclero-
sis the patient's habits, mode of life, occupation and methods
of living, require detailed investigation. Occupations and
diversions that involve physical overexertion, undue fatigue
or great worry and responsibility should if possible be changed
for those that are less taxing both physically and mentally.
Working at high speed and hurrying should be absolutely elimin-
ated and an adequate amount of rest is essential. In the more
senile types of arteriosclerosis, progressive loss of mental and
bodily vigor makes it impossible for the patients to continue
with their accustomed duties, and circumstances rapidly force
them to follow an altered existence commensurate with their
bodily powers. In the middle-aged arteriosclerotics, especially
those with high pressures, it is always a matter of great im-
portance, but may be one of extreme difficulty, to induce them
to relinquish their work and responsibilities and to lead an
orderly and more restful life.

Although focal infections may not be the actual cause of
any given case of arteriosclerosis, the constant presence of
such infections tends to aggravate the disease. Therefore,
any possible foci should be promptly eliminated.

The further treatment of arteriosclerosis, whether it be of
the high tension type encountered in middle-aged people or
the involutionary type, calls for careful detailed regulation of
the diet, exercise, elimination, bathing and the management
of any sequelæ or complications which may arise.

The diet in arteriosclerosis has to be modified to meet the
individual needs of the patient. In constructing a proper
dietary, consideration must be given to numerous factors such
as the age of the patient, the general nutrition, whether obesity
is present or whether there is loss of weight, the presence or

absence of anemia, the condition of the blood-pressure, the condition of the digestive tract and the bowels, the efficiency of the cardiac musculature, and whether or not renal involvement has taken place and if so, to what extent renal function is impaired. If the patient is poorly nourished and anemic, the diet should be liberal and of high caloric value, and proteins should be given as freely as is consistent with the other conditions present. In those who have been large eaters and are obese, dietetic restrictions should be rigid, and the caloric value of the diet reduced to the minimum. The degree of protein restriction should be regulated by the evidences of nitrogenous accumulation in the blood as well as the total renal function, always bearing in mind that in anemic individuals with poor heart muscles, too great a restriction of the proteins may further damage the degenerated myocardium. As in essential hypertension, the regulation of sodium chloride intake must depend upon the amount of sodium chloride retention that is demonstrable. When circulatory failure supervenes and there is a tendency to edema, the fluid intake must be reduced.

In general for the ordinary arteriosclerotic the diet should be varied and mixed and the total amount of food taken distinctly reduced in comparison to the amount of food habitually eaten. Protein food need not be eliminated but should be restricted. As a rule, one helping of ordinary size of some form of meat, once a day is allowable. There seems no reasonable objection to eggs being taken once a day. Stock soups should not be taken. If myocardial weakness does not exist and the blood-pressure is not excessive, no marked restriction in water need be enforced. All highly seasoned foods, such as rich sauces, all organs such as brain, liver and kidney, smoked, dried and salted fish, salted meat, rich desserts and pastries, as well as coffee, tea and alcohol should be carefully excluded from the dietary. It is well if possible to have the largest meal in the middle of the day.

A diet list suitable for the average case of uncomplicated arteriosclerosis is as follows:—

Breakfast: Cereal, such as cream of wheat, wheatena, rolled oats, hominy, rice, and some of the prepared cereals with sugar and cream. A roll or toast, dry bread, pulled bread, or zwieback with butter. Jams and preserves may be taken if

desired. Milk or cocoa, and after meals, stewed, baked or fresh fruits.

Dinner: A moderate helping of chicken, lamb, mutton or fish, broiled, roasted, or baked but never fried. Cream soups or purées. Potatoes, baked, mashed or creamed, or plain macaroni or spaghetti, hominy or rice. One or two varieties of fresh green vegetables, excepting peas and beans. Dry bread, stale bread or toasted bread with butter may be taken in reasonable quantity. Stewed or baked fruit or a simple pudding such as custard, junket, rice pudding, blanc mange, floating island, etc. At times plain ice cream may be taken as a dessert. If desired a glass of milk or water may be taken with dinner.

Supper: One or two eggs, soft boiled, poached, scrambled or plain omelette. At times eggs may be varied by a small helping of fish or by a few stewed, panned or broiled oysters. One fresh green vegetable and any of the starchy vegetables referred to for dinner. Stale, dry or toasted bread if desired. Stewed, baked or fresh fruit, or preserved and canned fruit, or a simple dessert, or a plain pudding may be taken.

If extra nourishment is needed with such a diet, it may be furnished by milk, with or without bread and butter or crackers between meals. As a rule, however, three regular meals of moderate size a day are sufficient.

In addition to the fluids contained in this diet list, five or six glasses of water may be taken daily.

Elimination has to be maintained freely through the bowels. As in essential hypertension, the habitual use of drastic cathartics is to be decried. Liquid petrolatum, agaragar and regulin as a supplement to such a diet as has been discussed, often help materially in promoting free evacuation. If these measures, however, are not sufficient, simple vegetable cathartics such as cascara, rhubarb, senna and licorice powder or phenolphthalein are usually adequate, and in sufficient doses will secure several free evacuations daily. Some arteriosclerotics apparently do better on small doses of various kinds of saline laxatives, given well diluted before breakfast.

In those who bear it well, sweating may be indicated. If it is to be employed, the same methods and precautions that

were dwelt upon under essential hypertension, are applicable
to arteriosclerosis.

Most all of those suffering from arteriosclerosis are bene-
fitted by daily warm baths. Cold baths, however, are usually
poorly borne and especially so by those who are suffering with
senile arteriosclerosis. Even in the more vigorous, and those
who are accustomed to cold water, when definite arterioslcero-
tic changes exist cold bathing is an unwise practice.

In the well nourished, younger and more vigorous arterio-
sclerotics, moderate outdoor exercise, if it does not entail much
effort, is often desirable, but in the more senile form of the
disease, as a rule all forms of exercise except a little quiet
walking, are contraindicated. Massage may be useful, but
only in those that bear it well and are not excited by it; it
should never be a deep or heavy massage.

There is no satisfactory drug treatment for arteriosclerosis.
From time to time various drugs have to be used to combat
certain symptoms. One group of drugs has always enjoyed
a reputation in all forms of arteriosclerosis and that is the
iodids. In some instances the iodids may be used to ad-
vantage and appear to relieve certain symptoms, but in
spite of the statements to the contrary, it is doubtful whether
the iodids exert any significant influence on arteriosclerosis,
except when a vascular lesion has a luetic basis. In specific
aortitis they often exert a beneficial effect. If the iodids in
the form of sodium and potassium iodids in saturated solu-
tion are not well borne, the syrup of hydriodic acid in doses
of a teaspoonful three or four times a day may prove a useful
substitute. In recent years a large number of so-called organic
iodin preparations have been put upon the market; by and
large they are no more, if as effective, as sodium and potassium
iodid. In some instances, however, they seem to be borne
better by patients. The great difficulties that have been
encountered in the prolonged administration of the iodids
are disturbance of the gastrointestinal tract and the occur-
rence of iodism.

There is little place in arteriosclerosis for the routine ad-
ministration of the nitrites and other vasodilators. For the
relief of angiospasm and angina they are often effective, but
aside from this use, even in cases that exhibit a persistent

high tension, their prolonged administration is attended with no noteworthy good.

Perhaps the drugs that are of the greatest use in arteriosclerosis are those that are helpful in regulating the condition of the gastrointestinal tract. In every case the state of the digestion should be carefully investigated and every effort should be made to maintain the digestion in the best possible condition. The alkalies, carminatives, stomachic bitters, and dilute hydrochloric acid, are all useful from time to time in managing the varied digestive symptoms so frequently associated with arteriosclerosis.

Throughout the management of a case of arteriosclerosis the greatest care should be exercised to do everything possible to maintain the integrity of the cardiac muscle and the functional efficiency of the kidneys. With the exception of cerebral hemorrhage, failure of either of these organs constitutes the greatest complication in arteriosclerosis. At the first indication of renal or cardiac inadequacy the treatment appropriate to the condition as outlined elsewhere, should be vigorously instituted. Another complication which adds to the gravity of the prognosis is the occurrence of angina pectoris. The treatment of this condition is detailed in the section devoted to that subject. The detailed management of such cerebral complications as hemorrhage, thrombosis and embolism, is more appropriately considered in the section devoted to the diseases of the central nervous system.

Excessive nervousness, restlessness and insomnia may prove troublesome symptoms in the course of arteriosclerosis, which if not promptly treated, tend to exhaust the patient. So far as possible, these should be treated by hygienic methods rather than by the use of sedatives. Fresh air, proper exercise, warm baths at night, gentle massage and hot drinks at bedtime, may all prove of use, but if these methods when persisted in fail, resort may have to be had to sedatives. Many arteriosclerotics stand sedatives badly; if much renal involvement exists their elimination is slow, and there is a decided tendency for them to accumulate and, after the routine administration for a few days, to produce marked and often disturbing toxic symptoms. One elderly sclerotic woman under the care of the writer, invariably developed a mild confusional state which

lasted from twenty-four to forty-eight hours when five grains of veronal were administered two nights in succession. Drowsiness and confusion may result from the administration of even small doses of bromide over several days. Whenever it becomes necessary to resort to sedatives or hypnotics in arteriosclerotic patients, it is always well to give the smallest possible dosage that will produce results, and never to continue these drugs for any length of time, and if hypnotics have to be used, to frequently change the preparation. Rest can frequently be obtained by the use of small doses of bromide, and if this proves ineffective, luminal in doses of one and one-half grains, administered at bedtime and repeated if it is necessary, will often prove a useful hypnotic. Veronal, adalin and trional in doses of five grains administered preferably in hot milk early in the evening, are often most effective in controlling the sleeplessness of arteriosclerosis. In some individuals in whom these hypnotics act slowly, they are eliminated with difficulty, and it is not unusual, therefore, to find when they are given late at night, that they have had little effect during the period when sleep was desired, but have produced in the patient profound apathy and sleepiness during the succeeding day.

Change of climate proves of benefit to some patients with arteriosclerosis, particularly when this change can be accomplished without subjecting the patient to uncomfortable living conditions or undue worry incident to leaving home. As a rule, the arteriosclerotics do better at a low altitude and in a warm climate. It is particularly desirable to have them spend the winter months in the south where they can enjoy a maximum amount of fresh air, sunshine and warmth. A sojourn during the winter months in a warm climate is also helpful in that it tends to prevent infections of the upper respiratory tract and the resultant pneumonia which too often proves the terminal event in arteriosclerosis.

Many of the European and English writers are prone to extol the advantages of certain of the watering places and spas of Europe in the treatment of arteriosclerosis. It is doubtful whether these cures possess any specific virtue in the control of the disease. It is more than likely that the freedom from care and worry, the regular life and the adequate rest and rigid

dietetic restrictions, usually associated with the various courses of treatment carried out at Continental health resorts, are chiefly responsible for the benefit that is alleged to accrue from certain cures.

ANEURISMS OF THE AORTA.

In the section devoted to arteriosclerosis it was pointed out that, as a rule, it is during middle life that degenerative vascular changes first manifest themselves. It is not surprising, therefore, that one of the gravest results of arterial degeneration, the production of an aneurism, the result of a giving way of the weakened vessel wall from undue strain, should also be associated with this period of life. For, as will be discussed later, it requires not only degenerated vascular tissue, but also increased intravascular tension and pressure to bring about dilatation of vessel walls. · Such conditions are met with less often in the aged, in whom even marked degrees of arteriosclerosis are usually associated with lessened physical activity and lowered blood-pressure, than in those who are in the fourth decade of life and in whom bodily vigor and the conditions which keep up blood-pressure are found in conjunction with varying degrees of vascular weakness. In short, an aneurism must be regarded as an affection peculiar to the conditions that obtain during the period of middle age.

To accurately define what is meant by the term aneurism is difficult. Many definitions there are but all are more or less incomplete and unsatisfactory and fall short of defining the term in the broad clinical sense that it is now used. On the whole, Osler's[86] definition that an aneurism is "a tumor containing blood in direct connection with the cavity of the heart, the surface of a valve or the lumen of an artery," is perhaps the best. This definition, however, does not include the symmetrical dilatations of the large vessels nor the abnormal communications between two vessels (aneurismal varix). Clinically, it is not well established as to just the degree necessary for a vascular dilatation to be termed an aneurism,

Classification and Pathology. Aneurisms may be single or multiple. They vary in size from minute bulgings along the smaller arteries, as at the base of the brain, to huge tumors the

size of a child's head and weighing five or six pounds, along the course of the thoracic and abdominal aorta. There are various classifications but the one adopted generally by most pathologists is as follows:—

1. True Aneurism.
    (*a*) Ectatic (Cylindrical; Fusiform; Cirsoid).
    (*b*) Sacculated.
    (*c*) Dissecting.
2. False Aneurism.
3. Arterio-venous Aneurism. (Aneurismal Varix; Varicose Aneurism.)

A true aneurism is a more or less localized dilatation of the arterial walls. Hence the wall of the aneurism in this variety is always made up of one or more, usually two, of the arterial coats. The media suffers most in arterial degeneration and as a rule is absent in the vast majority of this variety of aneurisms. The intima and adventitia also show marked changes but persist.

(*a*) In the ectatic variety the aneurism is made up of all the coats of the artery. There exists a more or less uniform dilatation in these cases and according to their shape two varieties are recognized, the cylindrical and the fusiform. In the cirsoid aneurism the artery is rendered tortuous by the unequal involvement of the different portions. The term cirsoid aneurism is also applied to groups of tortuous vessels lying beneath the skin, as upon the scalp and outer surface of the thigh. In reality such a condition is due to a thickening of all the coats with a corresponding increase in length of the vessels without any dilatation.

(*b*) The sacculated aneurism is the most frequent and important variety. It appears as a definite tumor bulging from the artery wall. In its formation the first process is the weakening and giving way of the media, followed by a gradual dilatation of the intima and adventitia. The resultant sacculation then has a direct communication with the lumen of the vessel. At each systole of the heart the opening into this sacculation is widened and the blood allowed to enter, thus furthering enlargement of the tumor. Upon section the tumor is made up of clots and laminated fibrin which does not show definite evidence of tissue organization.

The surrounding tissue is pushed aside ȯr is compressed. In many cases actual necrosis takes place. In sacculated aneurisms of the ascending aorta the ribs and sternum may be eroded. The tumor then projecting beneath the skin where it may rupture. Aneurisms of the transverse arch may compress or erode into the trachea or one of its main bifurcations. Both recurrent laryngeal and phrenic nerves may also be compressed. Posteriorly the aneurism may erode the bodies of the vertebræ with subsequent compression of the spinal cord.

(c) As the result of intimal rupture from a mechanical injury or a degenerative lesion, the blood may find its way between the tunics of an artery, forming the so-called dissecting aneurism. The dissection usually takes place in the media. The adventitious canal thus formed may be subsequently lined with endothelial cells which are then subject to atheromatous changes. Thus formed the column of blood may burrow between the vessel coats for a variable distance and then again break into the main artery. Dissecting aneurisms are usually found in the aorta.

False aneurisms result from wounds or rupture of an artery, causing a diffuse or a circumscribed hematoma that remains in communication with the blood stream. The hematoma then becomes encapsulated by a condensation of the surrounding tissues which form its capsule. Later such a hematoma may be lined with endothelial cells. The mass may finally be subject to fibrous tissue formation and possibly calcification.

An arterio-venous aneurism is formed by trauma, causing a direct communication between the artery and its accompanying vein (aneurismal varix) which subsequently enlarges. At times there is a definite sac interposed between artery and vein through which communication is established (varicose aneurism).

Etiology. In the formation of all aneurisms there are two factors which go hand in hand. The first is the degeneration of the arterial wall, principally the media; the second is the pressure within the artery which at each systole of the heart tends to stretch the diseased portion of the artery. A third condition, that of internal trauma, caused by muscle strain, may also be added.

Among the conditions which favor the degeneration of the arterial wall, syphilis is by far the most important single factor. Before the discovery of the Wassermann reaction, clinicians had looked for a long time upon all aneurisms occurring before the age of sixty years as due primarily to syphilis. Since the routine use of the Wassermann reaction has been adopted, more and more cases are proven to be of luetic origin. As far back as 1876 Francis H. Welch[87] in his investigations in the British Army, found sixty-six per cent. of his series had had lues. His description of the macroscopic changes in the aorta were typical of those of syphilis. While all the arterial coats are involved in syphilitic aortitis the lesion is primarily a productive mesoaortitis, which is characterized by a perivascular infiltration about the vasa vasorum, a small celled infiltration in areas of the media and a splitting, separation and destruction of the elastic element in the muscle cells. Syphilis primarily attacks the first portion of the root of the aorta and it is for this reason that the greatest number of aneurisms are found in this location. Because of the associated sclerosis of the coronary arteries, angina pectoris often occurs early in that disease. In addition, when the aneurism is low down stretching of the aortic ring, with at times a secondary erosion of the aortic valves, may take place, thus producing aortic insufficiency. Syphilitic aneurisms are more apt to be multiple than the non-syphilitic types.

In their recent statistical study, Lucke and Rea,[88] found 321 aneurisms in a series of 12,000 autopsies. In all, aneurisms were found in 268 subjects or 2.2 per cent. of all patients coming to autopsy in the Philadelphia General Hospital and in the Hospital of the University of Pennsylvania. These statistics indicate that aneurisms are not uncommon in America. It is also a well-known fact that the frequency of aneurisms differ in various locations. In 1905 Osler stated that in a British Army Home Contingent with a strength of 18,224 there were eighteen deaths from aneurism. During 1904 and 1905 in Germany, with an army of 555,777, there were four deaths from this cause. Wolpert[89] at the Medical Clinic at the University of Berlin during the ten year period, 1895 to 1905, studied 74,744 patients in whom aneurism was diagnosed in 55 instances, *i.e.,* one person in 559. Eichhorst[90] at the Medical Clinic of Zurich,

<div align="center">TABLE No. 1.</div>

LOCATION OF THREE HUNDRED AND TWENTY-ONE ANEURISMS.

	Number	Total
Heart and its valves		15
Heart	13	
Heart valves	2	
Aorta		278
Sinus of Valsalva	10	
Ascending arch	62	
Junction of ascending arch and transverse arch	23	
Transverse arch	46	
Descending arch	42	
Entire arch	19	
Arch (unclassified)	4	
Entire aorta (dissecting aneurism)	1	
Thoracic aorta	31	
Abdominal aorta	40	
Aortic branches and pulmonary artery		28
Ductus arteriosus	1	
Coronary artery	1	
Innominate artery	13	
Left carotid artery	1	
Pulmonary artery	1	
Superior mesenteric artery	1	
Celiac axis	1	
Splenic artery	6	
Renal artery	2	
Internal iliac artery	1	
	321	321

1884 to 1901, found 28 patients with aortic aneurism among 33,377 patients, or one in 12,000. Dahlen[91] at the Seraphin Hospital, Stockholm, found 222 patients with aortic aneurism in a series of 15,000, or one in 790. At St. Bartholomew's Hospital,[92] between 1867 and 1883, 90,000 cases were studied and 228 aneurisms were found, or one in 330. In this country Osler[93] found at the Johns Hopkins Hospital, 231 aneurisms of the aorta in 24,363 admissions to the Medical Clinic, or an incidence of one in 105 patients. From a post-mortem standpoint aneurisms are also more frequently found in the United States and England than on the Continent. As to the possible cause for this increase in frequency in the United States and Great Britain, Lucke and Rea[88] suggest that in these countries we have a type of syphilis which tends particularly to involve the vascular system. Following along the lines of

Marie and Levaditi[94] they have suggested that there is a special strain of the spirochete causing these lesions. To further emphasize this possibility, Lucke[95] in his statistical study found tabes dorsalis frequently among the American whites but rare among the negroes. On the other hand, the proportionate incidence of aortic aneurism is far greater in the negro than in the white population,

The location of aneurisms is best exemplified by the table on the opposite page from Lucke and Rea's study, which is quite similar to other statistical studies.

Aneurisms may occur at any age but are most frequently found in middle life. In Lucke and Rea's statistics the youngest patient was twelve days old and the oldest ninety-one years. It is to be noted, however, that the vast majority of them occur in the fourth and fifth decade. It should be remembered that at this time of life arteriosclerosis, hard work and muscular effort associated with hypertension are most common. The age incidence in Lucke and Rea's series is as follows:

TABLE No. 2.

INCIDENCE OF AORTIC ANEURISM ACCORDING TO AGE.

Under 20 years of age 1
From 20 to 29 years 9
"   30 to 39 "   32
"   40 to 49 "   81
"   50 to 59 "   60
"   60 to 69 "   42
"   70 to 79 "   18
"   80 to 100 "   4

It will be noted later that mycotic embolic aneurisms occurred in the vast majority of cases at an earlier period of life. In the United States aneurisms occur at an earlier age in the colored race than in the white population. This is probably accounted for by the prevalence of syphilis among the colored race in addition to their hard work as stevedores, laborers and the like. Aneurisms are also more frequently observed in the male sex, the proportion usually being about four to one.

INCIDENCE OF RACE, SEX, AGE AND RACE-SEX RATIO.

Race or sex	No. recorded	Average age	Race—Sex ratio
White	173	54.4	2.3 white: 1 negro
Negro	74	45.3	
Males	200	46.9	4.2 males: 1 female
Females	47	52.8	
White males ...	134	51.3	3.4 white males: 1 white female.
White females .	39	57.6	
Negro males ...	66	42.5	8.2 negro males: 1 negro female.
Negro females .	8	48.1	

Other causes of aneurism, although much less important than syphilis, are arteriosclerosis, congenital defects of arteries, adhesions pulling the arterial wall outward, mycotic infection of arteries, trauma and erosion of the vessels as occurs in gastric ulcer and carcinoma.

Certain intoxications and chronic infections play a part in aneurismal formation in-so-much as they may directly produce arteriosclerosis, or may bring about persistent high tension, which in turn favors arteriosclerosis. For example, lead has a decided action in the causation of sclerosis. Tobacco and possibly alcohol play less definite rôles in this connection. Diabetes and gout are important. Hard work, especially in those where muscular effort is constant, is a conspicuous cause of aneurism, especially when any of the above intoxicants are superadded.

Bacterial infections from without at times are causative factors. More frequently is this true in tuberculous cavities. The infection first attacks the adventitia, then the media and lastly the intima. When the wall is thus weakened the pressure from within causes the aneurismal bulging. Mediastinal lymph glands may also ulcerate into the aorta.

Wolferth and Stengel[96] have just reviewed the literature and collected 213 cases of mycotic embolic aneurisms of intravascular origin, of these 143 involved the peripheral arteries, while only 66 involved the aorta. Their distribution is shown in Table. No. 4.

TABLE No. 4.

THE DISTRIBUTION OF MYCOTIC ANEURISMS OF INTRAVASCULAR ORIGIN.

Artery affected	No. of cases in which artery was found affected	Total aneurisms
Aorta	66	88
Innominate	2	2
Vertebral	1	1
Basilar	4	4
Internal carotid	3	3
Anterior cerebral and main branches	3	3
Middle cerebral and main branches	14	23
Posterior cerebral	1	1
Posterior communicans	2	2
Small or unspecified cerebral	14	49 *
Subclavian	1	1
Axillary	3	3
Brachial	10	10
Radial	5	5
Ulnar	5	5
Common iliac	7	7
External iliac	2	2
Internal iliac	1	2
Gluteal	3	3
Femoral	14	15
Profunda femoris	2	2
Popliteal	5	5
Posterior tibial	8	8
Coronary	8	21
Superior mesenteric and branches	24	38
Splenic and branches	15	15
Renal and branches	5	5
Hepatic and branches	18	18
Pulmonary	6	6
Pulmonary and branches	8	31 †

In all the cases of mycotic embolic aneurism systemic infection of some character was the etiological factor. Subacute infective endocarditis was present in 184 cases. This type of endocarditis was characterized by subacute or subchronic course, luxuriant vegetation in the heart valves, bacteremia and wide spread embolism. The aneurisms may also occur in the highly malignant type of endocarditis. In the remaining twenty-nine cases, lung and bone infections were the most frequent sources of the bacteremia. Bacteriologically, when cultures were made the non-hemolytic streptococcus

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* Numerous in two cases.   † Numerous in one case.

was most frequently found. Other organisms found were the staphylococcus, pneumonococcus, influenza bacillus and the gonococcus.

Mycotic infection of arteries from within leading to aneurismal formations occurs in the following ways: (1) By lodgment of infected emboli in the lumen of vessels or in the vasa vasorum. (2) By the settling of bacteria from the inner surface or in the vasa vasorum. (3) By continuity or contiguity of infection from the aortic or pulmonic valves. Nearly always mycotic embolic aneurisms in the systemic arteries are associated with left sided endocarditis and in the pulmonary arteries with right sided endocarditis. Mycotic embolic aneurisms usually occur earlier in life than other forms of aneurism. The following table, formulated by Stengel and Wolferth, shows the age incidence of such aneurisms. The youngest child in whom the condition was noted was aged four years, whereas the oldest case observed was aged seventy-eight years.

TABLE No. 5.

AGE OF PATIENTS WITH MYCOTIC ANEURISMS OF INTRAVASCULAR ORIGIN, ARRANGED BY DECADES.

Age		Number of years
1 to 10 years		14
11 to 20 "		50
21 to 30 "		56
31 to 40 "		32
41 to 50 "		14
51 to 60 "		5
61 to 70 "		1
71 to 80 "		1

Symptoms. It is not unusual for an aneurism to remain undiscovered until it has advanced so far as to produce symptoms of pressure and not infrequently its presence is unsuspected until it is revealed by an x-ray examination taken for other purposes or discovered at the post-mortem table. The growth of the aneurism *per se* does not, as a rule, produce any symptoms, all of the distress complained of resulting from compression of the adjacent structures. Aneurisms which are so located as to miss important structures within the chest may grow to an enormous size without causing the patient discomfort. A large proportion of

the dilatations near the sinuses of Valsalva are free from symptoms and only give evidence of their presence at the time of death by rupture into the pericardial sac. When the aneurism is located low down in the first part of the aorta the aortic ring may be dilated and symptoms of aortic insufficiency dominate the clinical picture. Further, because of the associated syphilitic aortitis the aortic valve segments may be involved giving rise to an actual aortic regurgitation. In these cases the myocardium usually shows at autopsy a widespread necrosis. For this reason such patients may exhibit the symptoms and findings of a failing myocardium causing death without giving any suspicion of an associated aneurism.

As previously shown, aneurisms occur at a time of life when the patient is usually a robust, well developed and well nourished individual. Probably the most constant symptom is the associated pain, which may be either dull, boring and constant in character or paroxysmal. In the beginning there may be only a feeling of weight or oppression beneath the sternum. Anginal attacks occur with their characteristic radiation. When the transverse arch is involved pain is less apt to be a constant association, but when the descending aorta is involved, pain is frequently complained of. The dorsal vertebræ become eroded and the spinal cord is compressed. Agonizing pain may be felt shooting around to the front of one or both sides accompanied by herpes zoster or hyperesthesia due to the pressure on the posterior spinal nerve roots. This condition may simulate the gastric crises of tabes dorsalis and if the compression be great enough may produce a virtual transverse myelitis. Shortness of breath, especially upon exertion or upon lying down at night, is another fairly constant symptom in the earlier stages. All other symptoms referable to aneurisms of the various portions of the aorta are due to the involvement of special structures pressed upon by the vascular tumor.

One of the most frequent structures to be compressed, thus giving rise to marked symptoms, are the laryngeal nerves. If the aneurism arises from the first portion of the transverse arch of the aorta involving the innominate artery, the right recurrent laryngeal nerve is involved, causing paralysis of

the right vocal cord.   If the aneurism involves the middle
or posterior portion of the arch of the aorta, the left recurrent
laryngeal nerve is involved, giving a paralysis of the left
vocal cord. This gives rise to aphonia, also to the typical
brassy or metallic cough, and at times difficulty in swallow-
ing.   Compression of the phrenic nerve as it lies behind the
pericardial sac may cause hiccough or a spasm of the dia-
phragm.   Pressure on the sympathetic fibers leading to the
neck will cause first a dilatation of the pupil of the affected
side followed by a contraction when the impulses are blocked.
Pressure upon the vagus may also cause attacks of syncope.
The aneurism may also compress the trachea, bronchi, or
any of their bifurcations, setting up a troublesome cough.
The cough is usually dry and hacking in character and very
persistent.   Pressure on the trachea or bronchi may also
cause actual dyspnea, usually inspiratory in character, due
to narrowing of the lumen of the structures compressed.
This in turn may cause a collapse of a portion of the lung.
If the aneurism is of sufficient size the lung may be entirely
thrown out of function causing imperfect areation.   Fibrosis
may then take place within the compressed lung and act as a
causative factor of the dyspnea and cyanosis.   In addition to
being the seat of fibrosis the lung may undergo further change
causing bronchiectasis and its usual sequelæ, bronchorrhea,
fetid bronchitis and gangrene of the lung. Especially is this
true when dealing with aneurisms of the descending aorta.
Aneurisms in this location are also likely to obstruct the es-
ophagus to which they are often attached, giving rise to dif-
ficulty in swallowing.   Clubbing of the finger nails, usually
unilateral, is not a rare finding.

Physical signs. *Inspection.* Aneurisms of the ascending
portion of the arch may compress the vena cava causing a
distention of the veins of the head and arms with a resultant
edema of the right arm and a turgescence of the vessels of one
side of the face.   A visible pulsation is one of the earliest
physical signs. It is most frequently observed at the right side
of the sternum above the level of the third rib and much less
frequently on the left side in a corresponding area.   In aneu-
risms of the transverse portion, pulsations may be seen in the
episternal notch.   These visible pulsations, especially in a thin

chested person, are not to be confused with those produced by the conus of the right ventricle which is found in the second left interspace, or the throbbing of the aorta in aortic insufficiency, Graves's disease, cases of aortitis with hypertension and in the severe anemias. Solid tumors of the mediastinum and chronic mediastinitis may also give rise to pulsations of a rather diffuse character. Corresponding to the visible pulsation, bulging occurs in most instances. It may, however, be so slight as to elude detection unless the keenest observation is practiced. This is probably best observed by looking from behind or from either side at the pulsation; always allowing the light to fall obliquely on the chest during observation. The chest must be entirely bared. As the disease progresses the ribs and sternum are eroded and the rounded pulsating mass projects externally only covered by the skin and subcutaneous tissues. Sooner or later the skin becomes discolored and the aneurism may rupture externally. In aneurisms of the descending aorta, the pulsating mass is located in the left interscapular space.

When aortic insufficiency is associated with an aneurism the cardiac impulse is usually displaced downward and to the left. Many aneurisms occurring late in life without aortic regurgitation do not give evidence of left ventricular hypertrophy. The character of the impulse depends entirely upon the state of the myocardium. A forceful heaving, regular impulse usually denotes a fairly competent heart muscle.

Unequal pupils and even a facial flush must be looked for, both phenomena being due to compression of the sympathetics. It should be recalled in this connection that unequal, irregular pupils may also be due to syphilis of the third cranial nerve. A light reflex will differentiate the two conditions. The upper eyelid may also droop upon the affected side. Unilateral sweating with a turgescence of the vessels of the face and neck are not infrequently observed.

Palpation. In palpating over the upper sternum in cases of suspected aneurism there are three distinct phenomena to be noted. (1) The aneurismal impulse which is of necessity synchronous with the cardiac impulse. The two resemble each other except for the feeling of nearness to the palpating hand

in the case of the aneurismal impulse which also has a definite
expansile quality associated with vigor and intensity. The
shock produced is definitely localized. In cases of severe
anemia, throbbing aorta, hypertrophied heart and chronic
mediastinitis the shock is diffuse, giving the impression that
its seat of formation is further away, and the expansile quality
is absent. When the aneurism is deep seated the above im-
pression is best elicited by bimanual palpation, one hand being
placed on the sternum and the other on the spine. (2) Over
the sac of the aneurism may be felt the shock of the first
sound or what is more important, the sharp tap of the second
sound (diastolic shock). Light pressure often elicits this to
greater advantage than does the heavier touch. (3) A thrill is
frequently felt over the region of the pulsation. It is systolic
in time and except for its localization does not differ from the
thrill felt over a sclerotic aorta.

The drawing downward of the larynx synchronous with
cardiac systole, is present in those cases where the aneurism
is attached to the windpipe or its bifurcations. This physical
sign is known as the tracheal tug or the Oliver-Cardarelli
sign, after the names of the discoverers. When present it is
a valuable sign of superior mediastinitis and not pathogno-
monic of aneurism. One of the most marked tracheal tugs
ever felt by the writer was due to a band of adhesions at-
tached to the arch of the aorta and to the trachea

The radial and carotid pulse may be unequal. This in-
equality has usually been described as a delay. Mackenzie
has shown, however, that there is no delay but merely a di-
minished amplitude of the pulse wave. The increase in the
height of the pulse wave is gradual and not abrupt as in the
normal. The systolic blood-pressure readings in the arms also
show inequality, usually being ten to thirty points lower on
the affected side. The diastolic pressure remains the same on
both sides.

Percussion. When the aneurism is near the surface and in-
volves the ascending arch, the area of dullness shading into
flatness is usually to the right of the sternum in the second
interspace. When the aneurism has taken a direction upward
and to the left, the dullness is in the third interspace to the
left and is continuous with cardiac dullness. In other cases,

there may be only a widening of the normal aortic arch dullness. This takes place in both directions, to the right and to the left. Another area which is important to percuss is the left interscapular space. Dullness and flatness are obtained here in aneurisms of the descending aorta. To prevent eliciting too great lung and bone resonance a light percussion stroke is always to be used.

Auscultation. The sounds heard over aneurisms depend to a great extent upon the condition of the myocardium and whether or not the aortic ring or valve segments have become involved. Over the aortic area there is often heard a long, loud, systolic murmur. This murmur is transmitted into the large vessels and in no way differs from that produced by an aortitis without dilatation or aneurismal formation. When the aortic valves are still competent the second sound is usually loud and metallic and it is transmitted over the region of the aneurism. When the aneurism involves the posterior portions of the transverse arch and the left common carotid, this metallic second sound may be heard in the vessels of the right side of the neck and not to the left. This has proven to be a finding of much value when taken in connection with the metallic quality of the second sound. When the aortic valves have given way or are eroded a diastolic murmur is present. At other times a constant hum, "bruit de diable," is heard. When fibrosis of the sac has occurred the systolic murmur may be absent. The diastolic murmur being the only one heard. Warfield[97] has found tubular breathing over the manubrium in cases of aneurism of the transverse arch and believes that it is a valuable help in diagnosticating tumors of the mediastinum. In aneurism of the descending arch the systolic murmur is the only one heard.

Aneurism of the Abdominal Aorta. Aneurisms may occur in any part of the abdominal aorta or its branches. It is far less frequent than aneurism of the thoracic aorta. Osler's ratio in the Johns Hopkins series was one to ten; in the series studied by Lucke and Rea it was one to six. Males are more frequently affected than females. The majority of abdominal aneurisms occur in young men. In Bryant's series sixty-three per cent. occurred before the age of forty years. This point is to be borne in mind as an aid in differential diagnosis in

ruling out dynamic abdominal aortitis in thin neurotic women.
Any portion of the abdominal aorta or its branches may be the
seat of the aneurism. They most frequently occur, however,
in the upper abdomen around the celiac axis. The commonest
type found is the saccular variety.

Small saccular aneurisms of the abdominal aorta may be
present for a long time without giving symptoms. The
patient may first call a physician's attention to it by com-
plaining of a throbbing sensation in the abdomen. Care should
be taken in making a differentiation between a blood tumor
and a pulsating aorta, especially in thin neurotic individuals.
Tumors, such as carcinoma of the stomach, may be easily
mistaken for an aneurism. It is not always possible to
elicit by manual palpation the expansile qualities of the
aneurismal pulsation. A good method to help differentiate
these conditions is to have the patient kneel on the elbows
and knees and observe if the tumor falls away from the
aorta and ceases to pulsate. Pain, while not as intense as
in other varieties, is probably the most constant symptom
of abdominal aneurism. It is usually continuous, dull and
boring in character. Especially is this true when the
bodies of the vertebræ have become eroded, which in turn
gives segmental hyperesthesia. There may also be shooting
pain into the legs simulating tabes. If the tumor mass is in the
upper abdomen pressure may be made upon either the cardiac
or pyloric end of the stomach giving rise to nausea and vomit-
ing. If the aneurism has involved the hepatic artery chronic
jaundice may be one of the findings. These aneurisms,
whether saccular or dissecting usually rupture into the retro-
peritoneal tissues. With the accumulation of the blood and
the association of the pain an acute surgical abdomen may be
simulated. Osler reports four such cases which were operated
upon for acute appendicitis. In addition to rupture retro-
peritoneally the aneurism may rupture into any of the ab-
dominal viscera. A psoas abscess may also be simulated. The
aneurism may burrow upward and rupture into the pleural
cavity. Embolism of the aorta below the sac may occur. One
femoral may be blocked with resulting gangrene of the leg.

X-ray Examination. No examination, where an aneurism
is suspected, should ever be considered complete until a

thorough x-ray study of the patient has been made. In many instances prior to the development of symptoms small aneurisms will be detected in the course of routine examinations for other conditions. The x-ray will detect these aneurisms earlier than by any other means. This allows treatment to be started at an earlier date, which is a distinct advantage to the patient. Fluoroscopic examinations to determine the expansile pulsations of the tumor mass are far more important than stereoscopic plates.

Differential Diagnosis. The conditions from which thoracic aneurisms must be distinguished are pulsating empyema, pulmonary tuberculosis, abnormal pulsation of the aorta and solid tumors of the mediastinum. In pulsating empyema careful examination, usually at the base of the lung where the greatest field of dullness or flatness is located, will tend to do much toward helping make a correct diagnosis. In empyema the pulsation is not expansile. The pulsations produced are caused by the pressure of the respiratory movements and are not synchronous with the heart beat. The systolic thrill of the aneurism is absent. Upon auscultation over a pulsating empyema the double murmurs of an aneurism are absent. Furthermore, x-ray examination shows the mass to be less circumscribed than that of an aneurism. In cases of doubt a small needle may be inserted to help make the diagnosis, without danger to the patient even though an aneurism is present.

Pulmonary tuberculosis may be mistaken for aneurisms of the thoracic aorta when they are in such a position as to cause pressure upon the trachea with a subsequent compression of the lung. Symptoms such as cough, expectoration, blood streaked sputum or even frank hemorrhage, fever, and emaciation may result from the pulmonary change due to the compressed lung. Tubercle bacilli are, of course, absent in aneurisms. In pulmonary tuberculosis there is as a rule absence of the characteristic cardiovascular findings.

Abnormal pulsation in the abdominal aorta is principally noted in neurotic females and in aortic regurgitation, and is found more frequently in females than in males. The abdomen is relaxed and no definite tumor mass can be made out. In cases of aortic regurgitation the abdominal

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aorta may be found to pulsate throughout its entire course, being more marked in the upper abdomen. At other times when spinal curvature is present, the abdominal aorta may be displaced, brought forward and made more accessible to palpation. Recognition of the spinal curvature under such conditions readily establishes the correct diagnosis.

Solid tumors of the mediastinum such as carcinoma, sarcoma, and enlarged lymph nodes do not have the deliberate, heaving and expansile qualities that are felt over an aneurism. The cardiovascular findings are also lacking in the case of solid tumors. The tracheal tug may be present when the growth is attached both to the aorta and the trachea. The auscultatory findings over the heart and over an aneurism are absent in the case of solid tumors. In certain cases when dealing with a pulsating sarcoma, a distinct bruit may be heard. This, however, is not as a rule as loud as the bruit of an aneurism.

At times aneurisms may be present which have partially healed and therefore do not pulsate. This makes the diagnosis more difficult, even though the x-ray examination and fluoroscopic examination are made thoroughly. Other aneurisms which do not pulsate are those which rupture into neighboring soft tissues forming a diffuse tumor. This is most frequently found in rupture of the abdominal aorta or any of its bifurcations. These patients may live for several months or soon after the rupture show the characteristics of an acute surgical abdomen. Haulke and Baker report such cases.

Prognosis. In dealing with aneurism of the aorta, there is no rule which can be followed to help formulate a prognosis. The size and position of the aneurism in relation to the important structures pressed upon, and the rapidity of growth, are the factors to be borne in mind. Aneurism of the ascending arch even though it has produced a definite bulging, has, under treatment and a careful life, been known to heal and the patient live on indefinitely and finally die of some intercurrent disease. At other times, a small aneurism accidentally discovered by x-ray, may rupture soon after its recognition. Lebert estimated that the period of evolution of an aneurism was from six months to four years. There is

at present a man under observation who has had a sacculated aneurism of the ascending and first portion of the transverse arch for the past four years. At the beginning he was placed in bed for a period of three months and the underlying syphilis treated. Since then he has worked fairly constantly as a steve-dore without causing increase in the size of the aneurism. He refuses to take other work because of his unfamiliarity with it. In Lucke and Rea's studies only forty-three per cent. of the aneurisms were recognized clinically, the remaining fifty-seven per cent. being only discovered at autopsy. Undoubtedly many of them had existed for several years prior to death. As the treatment of syphilis is carried out more thoroughly the number of aneurisms will decrease and the evolution time will be prolonged as well.

At the Philadelphia General Hospital where aneurisms are not uncommon, there is rarely a death from rupture. Some authors believe that this is the common cause of death, but in the writer's experience such is not the case. Angina pectoris, myocardial decompensation and exhaustion are by far the most frequent modes of termination. The association of angina pectoris and aortic regurgitation with myocardial insufficiency always makes the prognosis exceedingly grave. The growth of the aneurism should be watched; probably more exactly by the frequent use of the x-ray. Attacks of dyspnea and blood streaked sputum are to be looked upon as danger signals demanding greater rest. The return of pain after its disappearance under rest is another signal of utmost importance.

Treatment. In the treatment of aneurisms all attention is directed toward two phases: (1) Influencing the formation of a clot within the aneurism and then strengthening its walls, and (2) reducing the constant pounding pressure from within, which is an equally important factor in the formation of the aneurism.

Rest is the most important measure used. By a prolonged rest, usually six to twelve weeks, the vigor of the heart's action is diminished, its rate slowed, and the flow of the blood stream lessened, all of which favors coagulation within the sac; the latter at times is also diminished in size. The rest should be absolute and prolonged. Under this simple measure, distress-

ing symptoms as pain, cough and dyspnea are relieved. The blood-pressure is also reduced by the rest which lessens the force from within.

Diet has not accomplished all that was hoped for it in the early days of aneurismal treatment. A low diet with a limited intake of liquids does good by reducing the blood-pressure. However, a partial starvation diet (ten ounces of solid food and eight ounces of fluid per day) as advocated by Tufnell, is only to be tried in very early cases occurring in the robust. The Valsalva treatment (to reduce blood-pressure and favor clotting) is in the vast majority of cases worse than the disease and is not to be recommended.

At the Philadelphia General Hospital wiring of the aneurism, plus the use of an electric current has given good results. However, to accomplish this, the aneurism must be accessible. The sacculated variety gives the best results. Wiring is contraindicated in the fusiform varieties. An insulated needle is inserted through the skin over the aneurism and directed into the sac. Then ten to thirty feet of gold and platinum wire (this combination has been found to be most useful as it is less liable to bend or break) is carefully and slowly inserted. The wire as shown by x-ray and post-mortem examination, coils up within the sac in a circular manner. The external end of the wire is then attached to the positive pole of the battery, and a large clay electrode is attached to the negative pole and placed under the back. The current is then gradually turned on, usually starting with a five milliampere current for ten minutes, the dose being gradually increased until forty milliamperes are given; the flow of the current is continued for fifty to sixty minutes from the time it is started. The needle is then withdrawn, the wire cut off and the operation is completed. In a case wired by Dr. Joseph Sailer five years ago, the end of the wire was found by x-ray examination to have entered the left ventricle for a distance of about two to three centimeters. It did not cause damage and the man was seen six months later on the street pushing a hand fruit cart. To the best of our knowledge he is still living and well.

Other measures formerly used to favor coagulation were the subcutaneous injection of two hundred and fifty cubic centimeters of a two per cent. solution of gelatin as advocated by

Lancereaux. Osler gave this a thorough trial in a series of cases with only slight improvement in a few. The procedure has been abandoned.

Of all the drugs used potassium iodid in fifteen to twenty grain doses three times a day seems to be most useful. In the syphilitic cases the pain is relieved with unbelievable promptness. Its action is undoubtedly upon the syphilitic mesoaortitis. As syphilis is the cause of the vast majority of aneurisms, it is reasonable to treat the underlying cause in the hope of stopping further destruction of the media. This must be carried out with great caution and the results watched closely or much damage may be done.

Arsphenamin and neo-arsphenamin should be used in small doses. Rarely should doses larger than 0.3 gram of the former and 0.5 gram of the latter be given. Mercury salicylate in 0.05 gram doses given once or twice a week over periods of eight to ten weeks with intervals of rest has proved to be of great aid. Especially is this true when iodids are given in combination.

To allay symptoms many other drugs are employed. When pain has not disappeared under the above measures, morphin should be given. If the case is hopeless as to cure when first seen, morphin should be given freely. Even after large doses when the vertebræ have been eroded the pain will persist. A hopeless patient should never be allowed to suffer for fear on the part of the medical attendant of creating a morphin habitue. If paroxysmal dyspnea is great, a little chloroform by inhalation will often give relief. When the heart is overactive or excitable and vascular tension high, veratrum viride is of use. Hydrated chloral is a valuable adjunct with morphin when sleeplessness is associated with pain. Ice bags to the precordium are at times useful

ANGINA PECTORIS.

Angina pectoris is not a disease, it is a symptom complex, a syndrome produced by various disturbances in the aorta, coronary arteries or myocardium, and characterized by attacks of precordial or substernal pain, referred to the upper portion of the body more especially to the left shoulder and arm, and accompanied by a feeling of impending disaster.

Angina pectoris because of its dramatic manifestations and grave prognosis, has always excited exceptional interest and perhaps no disease has ever been so carefully studied by so many distinguished physicians; certainly no disease has ever claimed among its victims so many celebrated members of the medical profession. All English speaking authorities take pleasure in according to Heberden the distinction of being the first to furnish an accurate description of the condition. This he did before the Royal College of Physicians in 1768. Most French writers, however, are inclined to give the credit to Rougnon of the University of Besançon, who in the same year is credited with having written a letter carefully describing a case of angina pectoris (Vaquez[98]). According to Sir William Osler,[99] Morgagni was in reality the first to publish an accurate description of a single case. The wide spread interest taken in this syndrome from the times of these early descriptions down to the present, have given rise to an enormous literature.

Etiology. All students of angina pectoris comment upon the frequency with which the condition is found in men as compared to women. In a series of 268 cases studied by Osler[100] 231 were men and 37 women. Huchard[101] found only 42 instances of true angina in women out of a series of 237 cases. In the writer's much smaller series, angina occurred three and one-half times more often in men than it did in women.

Age. Angina pectoris cannot strictly speaking be looked upon as a disease of middle life. Cases rarely occur before the age of fifty. In Osler's series[100] only nine cases occurred under the age of thirty. The greatest number were observed between the ages of fifty and sixty, whereas well over half the total number of cases fell between the age period of sixty and seventy years. In the group studied by the writer, no case occurred under the age of forty years. Three-quarters of the cases were observed between the ages of fifty to seventy years. In a recent analysis made by Gallavardin[102] there were only seven instances in women out of a total of one hundred cases. Only four per cent. were under the age of forty years, whereas twenty-nine per cent. were over sixty years.

It is generally recognized that angina pectoris is a condition rarely met with in the general hospital. The type of individual

found in the wards of hospitals, even though they frequently exhibit marked arteriosclerosis, is not drawn from the social group that suffer from angina pectoris. The condition is not infrequently encountered, however, in private practice among the better class of patients. The affection seems to be peculiar to those who work with their minds rather than with their bodies and who at the same time are subjected to the strains, worries, and responsibilities affecting professional and business life.

The frequency with which angina pectoris is met with among doctors has repeatedly been alluded to by many writers. Osler in his several admirable treatises on the subject of angina pectoris has discussed this interesting feature of the incidence of the condition in considerable detail. One-sixth of all the cases of true angina pectoris personally observed by the writer, occurred among physicians.

A close relationship exists between angina pectoris and arterial degeneration, therefore, much that has been said concerning the etiology of arteriosclerosis is equally applicable to the fundamental causes of angina pectoris. Hereditary, infections, notably syphilis, various exogenous and endogenous toxemias, such as gout, diabetes, nephritis, overeating, alcohol, tobacco, and the wear and tear of a high tension existence have all been recorded as etiological factors in angina pectoris, but their relationship to the affection is an indirect one and they are causative only in so far as they are capable of producing arterial changes in the aorta and the coronary vessels. It cannot be said that arteriosclerosis in general produces angina. The frequency of the former condition in contrast to the comparative infrequency of the latter affection, make it evident that most arteriosclerotics do not suffer from this disturbance. This is particularly true of those who exhibit arteriosclerosis of the peripheral vessels such as is found in laborers and in the senile form of sclerosis. Angina is a more frequent complication of the sclerosis associated with high pressure than of the involutionary type. It would appear that it is only when arteriosclerosis either produces lesions in the aorta or coronary arteries that interfere with the nutrition of the heart muscle, or, by reason of the high blood-pressure that may be associated with the sclerosis, throws an added burden

upon the myocardium, that arteriosclerosis induces angina pectoris.

Chronic valvular heart disease may be held responsible for some cases of angina pectoris. The vast majority of cases of chronic endocarditis, however, are noticeably free of all cardiac pain that can be regarded as true angina. The one lesion in which angina pectoris occurs with any degree of frequency, is aortic insufficiency. It occurs especially in the form of aortic insufficiency that results from lues. Here again it seems probable that the angina is the outcome of the associated aortitis and the interference with the coronary circulation that readily occurs in that valvular affection. Angina rarely occurs with mitral disease, but it is occasionally observed in association with mitral stenosis in young women.

Pathology. The obtrusive feature of the pathology of angina pectoris is that in practically every case some form of arterial disease exists. The most satisfactory grouping of the arterial lesion associated with angina, is that given by Osler.[103] He points out that in one group of cases the responsible lesion is aortitis. The one form of aortitis that is chiefly responsible for angina is the syphilitic. The details of such lesions have been discussed under arteriosclerosis, but in connection with angina pectoris it is important to recall that luetic mesoaortitis chiefly involves the root of the aorta and is prone to cause obstruction at the orifices of the coronary arteries. The non-luetic and senile forms of atheroma of the aorta are much less frequently associated with angina pectoris. Attention has often been called to the not infrequent occurrence of angina pectoris with aortic aneurisms, especially when the aneurism involves the root or first part of the ascending aorta.

The second and most commonly encountered group of vascular lesions in angina pectoris are those of the coronary arteries. All observers stress their importance in this connection. Interference with the coronary circulation may be brought about in two ways: First, the orifices of the coronary arteries may be narowed or obstructed. by the lesions of an aortitis. Second, one of the main coronary vessels or some of its branches, may be obstructed by a thrombus. The anterior branch of the left coronary artery is the one most fre-

quently occluded. The severity of the symptoms that result from thrombosis or embolism depends upon the size of the coronary vessels involved. The sudden, acute, fatal attacks of angina pectoris are in all likelihood the result of a fresh thrombus in one of the main coronary branches. If a patient survives such occlusion an anemic infarct of the heart wall results. Third, obstruction of the coronary circulation may be the result of an obliterating endarteritis. Such interference with the circulation is usually gradual, and varies markedly in degree and in extent. Sometimes the obliteration of the vessel lumen is so great that complete occlusion occurs. The process may occur in the larger or the smaller vessels, and in some instances it is widespread.

Some of the cases of angina pectoris that have come to autopsy have exhibited marked tortuosities and constrictions of the coronary arteries, often without any severe grade of obstruction of the vessels.

In addition there is a small, but definite group of fatal cases of angina pectoris in which neither the aorta nor the coronary arteries show any demonstrable lesion, which strongly suggests the possibility that spasm alone of the coronary arteries may be responsible for some instances of the disease.

In most cases of angina pectoris evidences of myocardial degeneration are present. Usually such degeneration is dependent upon disturbances in the coronary circulation, but occasionally no such interference can be demonstrated pathologically. In other instances pericarditis is the only lesion found in connection with those succumbing to angina pectoris, and at times chronic valvular disease is the only demonstrable condition that may have had a bearing on the affection.

The Mechanism of Angina Pectoris. The mechanism by which the attacks of angina are brought about have caused much speculation and numerous theories have frequently been put forth. It is said that Huchard[104] was much interested in this problem and collected as many as eighty different explanations for the phenomenon. In spite of so much speculation and a large amount of work directed toward solving the problem of how the symptoms of angina pectoris are produced, the question is still undecided.

One theory which has many advocates is that angina pectoris is analogous to intermittent claudication observed in the muscles of the extremities. In other words, that the contracted or partially occluded coronary vessels admit sufficient blood to maintain the heart muscle so long as no undue strain is thrown upon it, but the moment it is called upon to perform extra work, the blood supply is inadequate, its ability to contract sufficiently is impaired, and pain is the outcome.

In his Lumleian Lecture, Sir William Osler,[103] states that angina results from an alteration in the working of the muscle fibers in any part of the cardiovascular system whereby painful afferent stimuli are excited. He further points out that spasm or narrowing of a coronary artery or even of one branch, may so modify the action and the tension of the heart, that it works with disturbed tension and, therefore, there are produced stretching and strain sufficient to arouse painful sensations.

Sir Clifford Allbutt[105] is inclined to deride all theories of vascular spasm, of which intermittent claudication is an example, as a cause for angina pectoris, and adduces a theory of his own that has much to recommend it. Allbutt holds that a suprasigmoidal aortitis is responsible for the great majority of cases of angina pectoris. He believes that a sudden rise in the intraäortic pressure, producing aortic distention, brings about stretching and irritation of the sensory terminal end organs that are found in greatest abundance in the connective tissue investing the supra-sigmoidal portion of the aorta. On this basis he explains both the local and referred pain of angina.

The hypothesis of Sir James Mackenzie[106] also has many adherents. He holds that angina pectoris is a reflex protective phenomenon brought about by exhaustion of the heart muscle. Such exhaustion being the outcome of the heart muscle struggling against too great a resistance, as when a normal heart muscle has to work against increased peripheral resistance, or a degenerated heart muscle is opposed to a normal pressure. In either event the relative disproportion between the strength of the heart and the resistance it has to overcome, produce the exhaustion. This state of exhaustion induces pain by means of what is termed a "viscero-sensory reflex." Briefly, this mechanism is somewhat as follows:—Stimuli carried from the

heart to the spinal cord, irritate the nerve cells that lie in close proximity to the fibers that convey the stimuli from the heart. This irritation of the adjacent nerve cells brings about a response in the shape of pain in the peripheral distribution of sensory nerves, and muscular contraction as the result of motor nerve irritation. By this theory he explains the sense of constriction of the chest so common in angina pectoris, as well as the characteristic distribution of the anginal pain. Mackenzie further believes that the hyperalgesia of the skin and muscles that so frequently persists for a variable length of time over the areas where the pains of angina were felt, are due to hyperirritable foci that persist in the spinal cord as the result of the violent stimulation to which it was subjected. The existence of these hyperirritable foci, make it easier for further attacks of angina to be provoked.

Exciting Cause. Regardless of what the underlying pathology may be, in every case of true angina there is always an exciting cause. Among these the most important is physical overexertion. This overexertion need not be in any sense violent, for ordinary and simple acts may at times induce the attack. Mental shock, anxiety, emotional disturbances particularly anger, excitement of any kind, exposure to cold, and overeating, particularly when it is followed by exertion, are the common exciting causes. It is probable that the attack actually is induced by the sudden elevation in blood-pressures which may result from the operation of any of these above mentioned causes. The usual forms of overexertion that bring on a paroxysm, are walking up hill, climbing up stairs, walking into a wind, and especially any form of exertion soon after a large meal. The attacks do not always come on immediately after exertion; not infrequently their onset is delayed for as much as several hours after the muscular effort has ceased.

Sometimes the pains come on as soon as exertion begins, but disappear following a short period of rest, after which the patient may often be able to continue exertion indefinitely. An example of this was recently furnished by a man aged sixty-six years, who for eight years has suffered from a mild recurrent form of angina pectoris, and stated that the pains always came on when he began to play golf, but that if he rested after playing the first and second holes, he was invari-

ably able to finish the remaining sixteen without the slightest
difficulty or discomfort. Strangely enough, certain forms of
exercise will induce pain while other forms that are even more
violent will not cause any discomfort. The writer had under
his care a patient who, because of attacks of angina, was un-
able to walk a block, on the other hand, he could ascend stairs
slowly without the slightest difficulty. Several patients have
been observed who played golf with impunity, but in whom the
slightest exertion on the city streets would always bring on
substernal discomfort. In most cases of angina pectoris
sudden exertion and any violent effort will induce the pain,
whereas moderate continued exercise fails to provoke the
symptom.

Numerous more or less unsatisfactory efforts have been
made to classify clinically cases of angina pectoris. Such a
classification seems desirable since cases differ widely as to the
severity of the symptoms. There is a tendency on the part
of some to group cases of angina pectoris under two headings:
Cases of true angina, and those of false or pseudoangina. Most
observers are in accord that the latter term is a bad one and
should be discarded. It was originally adopted to describe
attacks of precordial discomfort and pain that were in no sense
due to angina pectoris but the result of toxic, nervous or
gastrointestinal influences. Such cases cannot be regarded
as instances of angina pectoris. For that reason the term
pseudoangina is unnecessary and should be eliminated, since
it not only means nothing but also gives a false impression to
patients. Many of the patients who suffer from these non-
anginal cardiac sensations are highly nervous and decidely ap-
prehensive over the possibility of having true angina; there-
fore, any term which embodies the word angina is apt to
augment their apprehension and alarm.

There are three well recognized clinical groups of cases of
true angina. First, those that have very mild symptoms or
only symptoms suggesting angina, the "formes frustres" much
dwelt upon by French authors; second, the mild form of an-
gina pectoris, or angina minor in which the pain is paroxysmal but
never severe; and third, angina major, the type characterized
by violent agonizing paroxysmal pain. This clinical grouping
has been repeatedly impressed upon the profession by the ex-

tensive writings of Sir William Osler on the subject of angina pectoris. The attacks sometimes begin as the mildest form and after repeated attacks ultimately develop into the more severe grades of the affection. In the writer's series, 22.5 per cent. of the cases could be grouped as "formes frustres," 35 per cent. as mild or slight, and 42.5 per cent. cases suffered from the typical forms of angina major.

The "formes frustres" are the mildest type and often go unrecognized because the symptoms may be so slight and transient. Patients in this class complain of a sense of substernal oppression and fullness, a sense of precordial discomfort that may gradually increase into definite pain. These mild conditions of angina may be induced by emotions or by any nervous strain. In many instances a slight muscular effort such as hurrying, or rapid walking or the indulgence in some form of exercise to which the individual is not accustomed brings them on. Frequently they are associated with vascular hypertension. Regardless of the cause of the hypertension, the cardiac symptoms are usually transient, and are never very severe, and the pain is not referred. However, in some of the high blood-pressure cases the substernal discomfort and the sense of constriction may recur frequently over a long period of time, or may be almost entirely absent. In these milder forms of angina the symptoms usually disappear promptly with rest.

In angina minor, the pain is cardiac, but is rarely severe. The condition is found more often in women than in men. The cause of the pain is usually mental or emotional disturbance, or comes from toxemia such as the excessive use of alcohol, tobacco, tea or coffee, sometimes it follows slight exertion, and it may be the result of some focal infection. For example a considerable number of those in the writer's series that fell in this group had their cardiac pain associated with chronic infection of the gall-bladder. In this mild form of angina, the pain may radiate into the left shoulder, and down the left arm, but neither the precordial pain or the referred pain ever attain the severity observed in the true attacks of angina. Mild angina rarely, if ever, results in a fatal termination.

Angina Major. Unfortunately the majority of cases observed fall under the head of angina major. The severe forms are nearly always associated with definite lesions of the myocardium, the aorta, coronary arteries or endocardium. Of the severe cases observed by the writer, seventy per cent. showed definite clinical manifestations of myocardial weakness, endocarditis or aortitis. Physical overexertion, overeating, or emotional disturbance are usually responsible for these severe attacks of pain. The attacks are always serious and often prove fatal. In the writer's series, fifty-nine per cent. of these severe cases of angina succumbed.

The paroxysmal pain of angina pectoris is characteristic and is either precordial or substernal. When of the latter type, it is often felt under the first part of the sternum, at the root of the neck. By some the distribution of pain is said to be suggestive of the underlying type of lesions. The pain which is definitely precordial, is said to be more likely the result of coronary artery disease, whereas the substernal pain, particularly that which is felt under the first part of the sternum, is attributed to aortitis. Typical attacks of pain are paroxysmal in character, and agonizing in their severity. The actual pain is often preceded or accompanied by a sense of constriction across the chest. It is not an uncommon thing to have patients describe their sensations as though the heart was gripped in a vise and was being violently squeezed. With the onset of the pain the patient becomes fixed and immovable, the countenance becomes pale and livid, perspiration stands out upon the forehead, and the expression of the face denotes not only agonizing suffering, but also a sense of overwhelming fear and impending disaster.

Many who have survived severe attacks of angina have vividly described the fear of imminent death that accompanied the paroxysm. The most severe pains last from a few seconds to a few minutes, but less intense pain may persist for several hours. In a severe attack observed in a physician, the pain which began at half after seven in the morning, showed but little abatement until three and one-half hours later. Following the attacks of pain, often for some days thereafter, areas of hyperesthesia in the region of the precordium may persist.

The pain of angina pectoris is referred in an exceedingly characteristic and almost diagnostic manner. The most usual radiation is up into the left shoulder and down the flexor surface of the left arm. The pain may extend only to the elbow, or may radiate down the forearm into the fingers and produce numbness and tingling in the fingers. At times the pain radiates not only down the left arm, but also down the right. In some instances the pain is not referred to the arm, but is referred up into the neck. In one of the writer's cases, very definite referred pain was observed in the left lower jaw. An explanation of the distribution of the referred pains of angina pectoris may be found in the theory of viscero-sensory reflexes advocated by Mackenzie.

The victim of angina may succumb during one of these paroxysms. During the attack there is no elevation of temperature but after the attack for several days slight fever may persist. It is the writer's experience that when fever follows an attack of angina pectoris, it is either the expression of an associated and perhaps causative aortitis, or results from fresh infarction of the cardiac wall. In one case that had had violent pains repeatedly, a particularly severe paroxysm was followed by fever for several days at the end of which time a fatal termination supervened. The autopsy showed a recent infarct involving the lower part of the left ventricular wall.

The insignificant effect which a severe attack of angina pectoris may have upon the heart, is an amazing phenomenon. In some attacks aside from slight acceleration the pulse is scarcely altered and the heart sounds may be surprisingly good and regular. During the attack the blood-pressure is almost always elevated, even in those who before the paroxysm have shown a perfectly normal pressure. In the writer's series a high blood-pressure was observed in a little less than fifty per cent. of the cases, whereas a blood-pressure that was normal or subnormal occurred in the remainder.

In addition to the cardinal symptoms above described, angina pectoris may be associated with vasomotor disturbances in which the extremities become numb, cold and mottled. In certain rather uncommon instances the attacks of angina begin with pain in some part of the body other than the pre-

cordium. In one group of cases the pain begins in the arms and may often be felt in the elbows. In other cases of angina the pain begins in some portion of the abdomen, such a condition is referred to as angina abdominalis. These abdominal pains are possibly due to vasomotor spasm and resemble the crises of tabes dorsalis, or may easily be mistaken for acute abdominal inflammations such as cholecystitis or appendicitis. Attacks of acute pulmonary edema with frothy blood tinged expectoration may follow or accompany attacks of angina pectoris. The paroxysms may also be accompanied by cerebral symptoms such as unconsciousness and even transient paralyses and aphasia have been observed.

Diagnosis. The typical cases of angina pectoris present no difficulty in diagnosis. The severe paroxysm once observed can rarely be forgotten. The character of the pain and its distribution, the fear of impending death, and the anguish of the patient, are all characteristic of true angina. In the cases of so-called angina abdominalis, there may be more difficulty in recognizing the condition. For example, if the pain is epigastric it has often been confused with the colic that is produced by a stone in the cystic duct. The milder forms of angina pectoris frequently offer a considerable amount of difficulty, especially when they occur in nervous individuals. A sense of substernal discomfort and oppression which characterizes the "formes frustres" may be overlooked for a long time and the true significance of the discomfort not appreciated. It is not uncommon for hysterical nervous individuals to complain of precordial pain, but instead of the pallor, immobility and apprehension characteristic of a true case of angina, such individuals are apt to complain loudly, become exceedingly excited and nervous, and walk about. The significance of the milder manifestations of angina are not generally well appreciated and it is no uncommon occurrence to see cases of mild or atypical angina that have been looked upon as instances of acute indigestion, intercostal neuralgia or muscular rheumatism.

Prognosis. Angina pectoris is always a serious disease, and in the majority of instances the ultimate prognosis is bad, although no attack may be so severe that the patient may not recover. Sometimes the condition may terminate with one

severe paroxysm, even in the first paroxysm; again there may
be a number of recurring attacks of great severity. In some
cases even after the most severe attacks, if the exciting cause
can be removed, no further recurrences may take place for a
considerable period of time. In those individuals who suffer
from persistent hypertension, or in whom there is definite evi-
dence of myocardial or aortic disease, the prognosis is always
grave. The well known uncertainty of the disease, offers great
prognostic difficulties. In one case personally observed, in a
large obese man of sixty years, who had a terrific attack of
angina, an early fatal prognosis was given because of the
obviously diseased condition of his myocardium and blood-
vessels. In spite of several severe recurrences, this individual
survived for nearly five years. In contrast to this may be cited
the instance of a well nourished, placid, somewhat anemic
elderly woman, who was seen in an attack of angina pectoris
in the forenoon. Owing to the apparent fair state of her
myocardium, and her ability to lead an ideal, quiet and care-
ful life, a guardedly favorable prognosis was given. · Before
the day was over the patient had died suddenly in violent
paroxysms of angina.

Patients who suffer from angina pectoris usually succumb
in one of two ways. They either die suddenly in a paroxysm
or myocardial insufficiency develops and the patient succumbs
gradually to decompensation. It is not an uncommon occur-
rence for the pain of angina to disappear after auricular fibril-
lation has set in. In this connection it is interesting to recall
that many years ago the late Dr. John H. Musser, himself a vic-
tim of this affection, called attention to the fact that the pain
of angina pectoris was relieved when mitral regurgitation de-
veloped. The cases of angina pectoris that offer the most
favorable prognosis are those that are definitely due to luetic
aortitis which is capable of being controlled by active treat-
ment.

Treatment. The treatment of this affection resolves itself
into two phases, first, efforts directed if possible toward the
eliminating of the cause and removing those features that
precipitate an attack, and second, the management of the at-
tack itself. Every effort should be made to discover if pos-
sible the underlying causes of this condition. Unfortunately

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more often than not, even if the cause be discovered, it will
prove to be one which cannot be removed. The great excep-
tion to this, however, is in the case of syphilis. As above
suggested, if lues exists and particularly if it has produced
a luetic aortitis, active antiluetic treatment should be insti-
tuted in the hope of limiting or clearing up the vascular lesions.
Much, however, can be done to prevent the recurrence of at-
tacks. The patient's life and habits should be carefully con-
sidered. The importance of an adequate amount of rest and
the avoidance of fatigue, should be insisted upon. All mental
and physical overexertion should be avoided. Patients should
be cautioned never to indulge in any physical effort such as
running up stairs, hurrying for a train, or carrying heavy
bags, etc. Worry, care and anxiety, should be eliminated so
far as possible, and patients should be cautioned about the
danger of giving way to their emotions, a matter of the greatest
importance in dealing with those prone to lose their temper.
Constipation should be avoided; the bowels should be opened
freely at least once a day and patients should be warned
against the danger of straining at stool. The diet must be
varied with the condition and habits of the individual, and
with any associated disease that may be present. In general a
diet as outlined in the management of arteriosclerosis is suitable
for most cases of angina pectoris. When a hypertension with or
without arteriosclerotic changes exists, the régime outlined
in considering hypertension should be instituted. In a similar
way suitable steps must be taken if a chronic nephritis is found
to be the underlying disturbance.

The Treatment of the Attack. When a paroxysm of angina
pectoris occurs, methods for its relief must be promptly insti-
tuted. The patient must be kept absolutely quiet. Frequently
the application of heat in the form of a hot water bottle or
electric pad over the precordium, affords a certain amount of
relief. Counterirritants such as mustard plasters may be tried.
None of these methods usually prove more than a useful
adjunct to active drug therapy. The nitrites have always
enjoyed a reputation for relieving the pains in angina. In
many instances, however, the results from their use are dis-
appointing. Inhalations of amyl nitrite may be employed, and
this drug is frequently carried by patients subject to attacks.

In some instances its effect is nothing short of miraculous. In many of the severe attacks, however, it accomplishes little. Glyceralis trinitratis may be administered by mouth, in solution, or as a tablet placed under the tongue or hypodermically, in doses of about $\frac{1}{100}$ of a grain. In some individuals erythrol tetranitrate acts more effectively than do the other nitrites.

· Although this group of vaso-dilators may do some good and may relieve the pain in certain individuals, the severe attacks of angina pectoris as a rule, require the exhibition of morphia hypodermically. Patients with angina are notably resistant to the drug, and adequate doses must be given. It is no uncommon thing to see a severe attack of angina require as much as half a grain of morphia to give any sense of relief. In most individuals it is a safe rule to follow, that if the attack of angina pectoris is severe, there is little to be gained by trying other remedies and the sooner an adequate amount of morphia is given hypodermically, the more quickly the patient will be relieved of distress and a possible fatal termination averted. Following the control of the pain, patients should be kept absolutely at rest and no activity should be allowed until the possibility of a recurrence is reasonably remote. Chloroform by inhalation has been used frequently to relieve the pain, and in some individuals in whom neither the nitrites nor morphia have much effect, chloroform may be the method of choice. In the arteriosclerotic individuals potassium iodide given between attacks, appears to do some good and to help prevent recurrences. It is, however, of no value in the acute pain. When angina pectoris is associated with evidence of myocardial weakness, the myocardial disturbance requires active treatment. When digitalis is necessary for the proper management of the cardiac condition, it may usually be given in adequate doses without inducing an attack of angina pectoris.

The most daring and yet perhaps the most hopeful suggestion for the treatment of this dread affection yet made, is that of Jonnesco[107] who advocates total resection of the cervical sympathetic including the first thoracic ganglion as a cure for angina pectoris. In the hands of this operator results are said to have been encouraging, but surgeons generally have not looked favorably upon the procedure which has serious tech-

nical difficulties. Nevertheless, it is not unreasonable to look forward with interest to further surgical progress in this direction.

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Diseases of the Kidney in Middle Life

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Diseases of the Kidney in Middle Life.

PART I.

INTRODUCTION.

In a consideration of diseases of the kidney occurring within the limits of middle life, one is at once faced with the fact that this limitation permits the omission of only a very few varieties of renal disease from the list of subjects to be discussed. Not that there are not certain types of nephritis, for example, more common in childhood, or of arteriosclerotic changes in the kidney more common in old age, but because almost all of these disease pictures may develop within the period of middle age. It is rather a question of proper emphasis on relative incidence and importance than one of exclusion. Congenital defects may not make their presence evident until early middle age; senile changes may become prominent prematurely. Such individuals might be said to be middle aged only in terms of years, but it is in years that we must define middle age. It is a widely inclusive period; cystic disease of the kidneys is said according to its variety to be found in the very young and in the old, yet the age of the patient whose case illustrates this condition in this article falls well within the limits of middle age. The field is encroached on at either end but there are certain characteristics of the diseases of the kidney which occur in this period and the attempt will be made properly to emphasize these.

It has seemed best, for the purposes of correlation, to refer as much as possible of the discussion of kidney disease due to arterial changes to the section on Diseases of the Arteries. It is obvious the division cannot be absolute, nor is it possible today to state how great a part primary arterial disease plays in the pathogenesis of what is commonly included under the term "chronic nephritis." Certain duplication will be inevi-

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table, but those conditions in which arterial disease is evidently of primary importance will receive but passing comment in this section, and the reader is referred elsewhere for the discussion of benign hypertension, arteriosclerosis of the kidney, etc.

The usual method of presenting the etiology, symptomatology, diagnosis, prognosis, and treatment of each separate variety of kidney disease under the individual disease heading has certain clear advantages. It does, however, tend to narrow the point of view and overemphasize the individuality of each single disease picture at the expense of the kidney and its functions as a whole. This would be more excusable if a satisfactory classification of kidney disease had been evolved and widely adopted. To date, however, partly as a result of failure to correlate successfully clinical disease pictures with evidences of disturbed function on the one hand and with post-mortem findings on the other, no such classification is available. Until such correlation is accomplished it will do us no harm to approach the subject of diseases of the kidney from the point of view of the organ as a whole, an organ with but a single function; to maintain at the normal level the composition of the circulating blood.

Failure of the kidney to perform its function constitutes what may be termed renal insufficiency, and this may be discussed with as much propriety as one discusses its cardiac analogue. Part I of the article contains, therefore, a discussion of the etiology of disease of the kidney in general, and chapters on the symptomatology and diagnosis of renal insufficiency, and on the treatment of certain of its associated manifestations. Part II contains brief descriptions of the various "disease pictures" which we recognize clinically and which we believe are wholly, or chiefly, the result of kidney disease. Much of the detail which goes to make up these pictures consists of some of the various manifestations of renal insufficiency.

Illustrative histories of actual cases have been introduced here and there, most of which are drawn from the records of the Hospital of the University of Pennsylvania. My thanks for this material are due to Dr. Alfred Stengel, Professor of Medicine in the University of Pennsylvania. At the end of the article a bibliography is given which includes certain gen-

eral articles as well as special articles covering individual points, or having helpful references to literature.

ETIOLOGY OF DISEASES OF THE KIDNEY.

In middle age just as in youth, disease of the kidney may arise from a great variety of acutely acting and often readily recognizable causative factors, but as middle age approaches and advances one also meets with increasing frequency renal disease brought about or initiated many years previously. Some causative factors may have exerted their entire harmful influence in early childhood; others may have acted continuously or intermittently up to the appearance of symptomatic disease. A given factor in one instance may produce acute results, while the same cause acting in lessened "dose" or over a shorter period may, in another individual, initiate subacute or chronic trouble. In still other cases, a chronic renal disease in middle age may be traced back to an earlier acute attack produced by an obvious but temporarily acting etiological factor; in such instances secondary causes, impossible perhaps to recognize, may subsequently have been at work, acting on the organ weakened by the primary insult. In youth the etiology of kidney disease is often apparent; in middle age the majority of cases remain unexplained. It is for these reasons that in discussing renal disease peculiar to middle age we must give careful consideration to a great variety of possible etiological factors. The list of possible factors is a long one, and is never complete; much more knowledge concerning this subject is needed both for the prevention of kidney disease and for its early treatment by the elimination, if possible, of the factors which brought it about.

Heredity. Not much attention is as a rule paid to this factor, although certain striking instances are on record. In the families reported a large proportion of the members developed nephritis, usually of a chronic type, in some families in early life in others not until between the ages of fifty and sixty. In most instances the disease proved fatal, even in the youthful cases. Less startling instances are common in which two or three members of a family develop the disease under conditions which suggest some familial predisposition. Not infrequently one hears a statement such as that made by a

man aged forty-six, with rapidly advancing chronic nephritis, that "several brothers and sisters have died of Bright's disease." In the family of a patient seen in terminal renal insufficiency, perhaps of primary arterial origin, there had been a number of similar deaths and the surviving members had adopted a fatalistic anticipation for themselves. One must be careful to remember, however, that members of a family are apt to be exposed to the same surroundings and habits of life; certain infections and dietary customs are shared to some extent. A true familial predisposition to renal disease may be present, however, and may in some instances be dependent on the familial occurrence of some one or other of the congenital factors next to be discussed.

Congenital. Formerly it was thought that malformations and displacements of the kidney exerted but little influence on the organ's functional capacity or on its liability to disease. It was, of course, recognized that absence of both kidneys was not compatible with life, and that when only one kidney was present the interference with its function by disease, injury or operation was a much more serious matter than if its fellow was present to take up the burden. It has also long been known that the movable kidney, many instances of which are the result of congenital faults, is liable to develop hydronephrosis and infections of the pelvis. Cystic disease of the kidney is another malformation which is recognized as predisposing to failure of renal function in adult life; and among others this form of congenital fault has been described as occurring in more than one member of a family, and of showing an hereditary tendency. Other varieties of displacements and malformations were, until recently, thought to have little clinical importance. Evidence, however, has slowly accumulated in favor of the view that almost every type of congenital deformity and displacement of the kidney renders it more liable to the development of nephritis, and, it is claimed by some, to calculus, tuberculosis and other infections. Even the misplaced kidney and the fused or horseshoe kidney exhibit this predisposition to disease, and one can speak with still greater certainty of the results when one kidney is absent, or one or both are markedly hypoplastic. In such individuals a definite tendency is present for the development of a more or

less chronic nephritis, sometimes at an early age, but in other instances not until the age of thirty or more.

The importance of such congenital factors in the etiology of kidney disease and renal insufficiency in middle age must not be underestimated. There may occur no symptoms of renal inadequacy whatever during youth, and the first premonition of trouble may be the alarmingly sudden appearance of uremia in perhaps the fourth decade of life. It is as though the congenitally weakened or deficient renal tissue had been able to carry on necessary function without obvious difficulty, until at last some apparently trifling extra demand resulted in serious renal insufficiency. Sometimes at autopsy a compensatory hypertrophy of the congenitally unaffected kidney is discovered; a compensatory effort which, however, has failed to avert the final renal inadequacy.

Two cases may be mentioned in illustration. One, a middle-aged man, entered the hospital because of pain under the right costal margin and fever. The upper right abdomen was slightly rigid but a large somewhat irregular mass could be felt in either kidney region. These were recognized as congenital polycystic kidneys but there were apparently no symptoms referable to them. The acute illness was believed to be an acute cholecystitis and seemed to be subsiding under medical care, until the favorable course of the case was abruptly interrupted by acute renal insufficiency. Death occurred in uremia and at autopsy typical cystic kidneys and an infected gall-bladder were found. Apparently the gall-bladder infection was the factor determining the onset of the kidney failure.

The other case, already reported in the literature, is one of fatal chronic nephritis in a fourteen year old girl. She had had scarlet fever at the age of seven, but no history of symptoms of renal involvement could be elicited. She had never been strong since, and her menses established at the age of twelve, had always been immoderate and accompanied by epistaxis. Shortly before admission she had become much weakened and anemic from continued epistaxis and menorrhagia. The blood-pressure was systolic 148, diastolic 132. The phenolsulphone-phthalein test gave no elimination of the dye in two hours and the blood urea nitrogen was two hundred and twenty-eight milligrams per one hundred cubic centimeters. She rapidly

grew worse, convulsive movements appeared, bleeding from the nose, gums and vagina persisted, and death occurred. At autopsy only one kidney could be found, and that organ weighed only sixty-five grams and showed severe chronic nephritis. The fatal renal insufficiency at such an early age was probably the result of the scarlet fever acting on a deficient and congenitally weakened kidney.

Dietary Factors. It is customary to suggest that certain foods and overeating in general may be of etiological importance in the production of nephritis usually of a chronic variety, and special emphasis has been placed on the possible harmfulness of an excessive ingestion of protein foods, of highly seasoned foods and of salt. Certain specific articles also have been suspected, for example, mustard and sorrel, the latter on account of its high content of oxalic acid. Leaving these substances out of consideration and postponing the discussion of chemical food adulterants, the question remains whether the excessive use of any usual article of diet, perhaps over a long period of time, may predispose to kidney disease. The generally accepted fact that limitation of protein and salt is beneficial in certain cases of hypertension and of renal insufficiency, is probably responsible for the assumption that these articles in excess can be harmful to the normal kidney.

Experimentally there is some evidence that the feeding of a diet very high in protein to animals over a considerable period will bring about definite renal lesions. Squier and Newburgh, furthermore, have apparently demonstrated that a high protein diet, at least when the protein is given in the form of meat, is a renal irritant, and will cause the appearance of red blood corpuscles in the urine of normal men. The albuminuria which may result from the absorption of unchanged proteins from the digestive tract under certain conditions does not permit us to conclude that the kidney is in any way damaged or at fault. In many infants such an alimentary albuminuria can be produced with egg white, and some adults exhibit the same phenomenon. A patient of mine was repeatedly rejected by the army on account of albuminuria, until it was discovered that by the omission of eggs from the dietary the urine was wholly freed of albumin.

Salt as an important factor in the maintenance of hypertension has been given prominence, and perhaps too much so, of late. There is no sure evidence that it has any causative effect in this respect. On the other hand there have been cases reported, one in a very young child, in which an edema was found apparently to have been produced by too high a sodium chlorid intake. In these cases there was no demonstrable kidney disease, and complete disappearance of the dropsy followed limitation of the ingestion of salt.

Indirectly diet may markedly affect the kidney. It may lead to enteritis which is in turn a frequent factor in the pathogenesis of pyelitis or other renal infections, and which in all probability also produces more or less renal irritation as a result of the toxic substances and bacteria which are absorbed in increased amounts from the disordered intestine. Abnormalities in the fluid intake if long continued might be considered as possible sources of renal irritation. An insufficient fluid intake or a diet resulting in the constant presence of certain salts in the urine, for example oxalates, may play a part in predisposing to the formation of calculi. Another way in which diet may indirectly act, is exemplified in the production or continuation of a diabetic hyperglycemia and glycosuria with subsequent renal failure. The influence of gout and alcohol will be discussed later.

In all considerations of the possible influence of diet on the kidneys, one must not forget that the harmful affects of abnormal diets, if there are any, may be primarily and chiefly on the arteries rather than on the kidney itself.

Infections. Without hesitation one can say that infection is by far the most important causative factor of kidney disease in general; important not only as to frequency, but also as regards prognosis. This is true for all age groups, but the conditions vary in the different periods. In childhood nephritis is usually of acute nature and follows some definite infection. Tonsillitis, angina, scarlet fever and streptococcus infections in general head the list of infections complicated by nephritic troubles, but diphtheria, pneumonia, typhoid fever, cholera, typhus fever and malaria must also be mentioned. Such acute attacks of kidney disease may be wholly recovered from, or the individual may be left "predisposed" to later kidney dis-

ease. This so-called predisposition may, in truth, be a chronic nephritis, giving no symptoms nor any evidence of renal insufficiency, by our present functional tests. In childhood also other kidney diseases than nephritis result from infection; thus, for example, enteritis and diarrhea are the common precursors of pyelitis.

In middle age the same acute infections may bring about acute renal disease, but such cases form a much smaller percentage of the whole. A few acute infections become more important, however, in this respect in middle age; typhoid and pneumonia in this period are frequently complicated by kidney disease, gonorrhea only becomes of importance after puberty is reached. In middle age, however, one is chiefly concerned with the results of acute infections suffered in childhood or with the influence on the kidney of subacute or chronic infectious processes.

Scarlet fever in youth is the infection which is most frequently accused of having initiated kidney disease which becomes apparent as a chronic nephritis in later years. Even if no renal disease is recognized at the time of the scarlet fever it cannot be doubted that this infection is of great importance as a factor in the later development of chronic nephritis. Accurate statistics are difficult to obtain and the fact that an attack of scarlatina is always inquired for in every case of nephritis, even if no other infection is questioned about, tends to discredit such statistics as are available. The pediatrician sees in scarlatinal nephritis a disease which is either fatal or entirely recovered from, and this may apparently be true to the best of our present day ability to recognize kidney disease in the stage of perfect functional compensation. This by no means implies that the organ has suffered no permanent damage.

Acute infections of the upper respiratory tract are of almost equal etiological importance in the production of nephritis; some writers place them at the head of the list. The appreciation of their importance is of fairly recent date and is still growing, and more and more emphasis is being placed on such acute conditions as tonsillitis and quinsy as the cause both of nephritis and of suppurative renal troubles.

Repeated minor infections such as "colds" and chronic focal infections are also to be considered in the etiology of renal disease. This is a matter still in doubt, but there is a growing tendency to believe that bacteria enter the blood stream from the intestinal tract or upper respiratory tract, or from foci of infection with considerable frequency and freedom. Depending upon the bodily resistance and the virulence of the organism widely varying results may occur. In the kidney such bacterial invasions may produce lesions as severe on the one hand as embolic septic nephritis and pyelonephritis, and on the other an almost, if not entirely, unrecognizable kidney irritation, which if sufficiently often repeated may lead to a true chronic nephritis. Bacterial endocarditis is another condition in which the kidneys suffer severely from lodgment in the glomerular tufts of bacterial emboli from the endocardial focus. The streptococcus is the usual invader and a not small percentage of cases of "malignant" or bacterial endocarditis die, apparently of renal failure. In all such cases with severe symptoms of renal insufficiency it is probable that there is a nephritis present in addition to the simple embolic lesions. It would seem that all blood infections must damage the kidney to some extent, but the bacilluria which so often occurs during or after typhoid fever and is usually unassociated with any evidence of kidney damage, seems to argue that the kidney can eliminate myriads of bacteria without injury to itself.

Trench nephritis, so-called, was probably due to an infection the nature of which is unknown. Similarly in many instances when a nephritis is attributed to cold or to exposure, it is probable that there was also an infection present. The direct importance of cold and wet has probably been exaggerated.

Albuminuria is almost constantly present during fever and there has been much discussion concerning its significance. It is best to consider it the evidence of a true nephritis even though the albuminuria may be the only finding. That a nephritis may exist and often does exist, without more demonstrable proof we must admit. Such mild nephritis is in all likelihood the explanation of febrile albuminuria, and it is to be correlated with the diffuse cloudy swelling of the kidney found at autopsy in these cases. Why certain infections produce so mild a reaction in the kidneys while others result in

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serious damage; why some injure the tubules especially and others the glomeruli, are questions we can not yet answer. Nor do we know the factors, congenital or acquired, which predispose one individual to severe kidney damage during an apparently mild infectious disease while another passes through a severe attack with merely the usual febrile albuminuria. Perhaps the invading organism varies; in former epidemics of influenza acute nephritis was a frequent complication, the opposite was observed during the epidemic of 1918 and 1919.

Tuberculosis and syphilis deserve special mention, for they may bring about renal disease both directly and indirectly. Tuberculosis of the kidney is by no means peculiar to youth, although the greater number of cases of miliary tuberculosis with involvement of the kidney occur in that age period. In middle age tuberculosis of the kidney is not uncommon and may appear either alone or combined with tuberculosis of the lower urogenital tract or of other organs. Acute or subacute nephritis is a relatively frequent complication of tuberculosis either of the lungs or otherwise; urologists refer to the constant occurrence of bilateral "toxic nephritis" with polyuria and albuminuria as a result of unilateral or bilateral renal tuberculosis. In pulmonary tuberculosis the toxemia due to secondary infection may play an important rôle in causing renal irritation. Often in such cases there is more or less amyloid degeneration of the renal parenchyma present. It is not unusual to find at autopsy little or no evidence of the nephritis one had diagnosed, but instead a marked degree of amyloid change.

Syphilis of the kidney appears occasionally in the form of gummata, usually small and multiple. Syphilitic nephritis is less certain although several varieties have been described. For example, British writers favor this etiology for certain cases of chronic nephritis in children and young adults. Undoubtedly albuminuria is frequent in the secondary stage of acquired syphilis, and many writers claim that acute syphilitic nephritis is not uncommon. Some, however, attribute this acute nephritis to the drugs employed in the treatment of the syphilis, but Anderson has presented evidence tending to prove that extensive treatment with arsphenamin can be given without injury to the kidney. There are still other writers who

claim that syphilis produces an almost pathognomonic picture
of kidney damage which Munk, for example, entitles "lipoid
nephrosis." Munk has claimed that the finding of doubly re-
fractile lipoid bodies in the urine is strongly suggestive of
syphilitic nephritis, but Stengel and Austin believe that the
presence of such bodies is not proof of the syphilitic nature
of a kidney lesion, although an abundance of them is highly
suggestive. The bodies do not occur in the urine of syphilitics
in the absence of other evidences of nephritis.

On the other hand, Christian states that he has never seen
a case of syphilitic nephritis, and Herringham has had no such
case in his experience. In looking over the records of a large
series of cases of kidney disease one is not struck with the
frequency of syphilitic infection except, perhaps, in one group
of cases. This group is composed of cases which would prob-
ably be better classified under the heading of arterial disease.
In such cases, often diagnosed as chronic nephritis because of
a predominance of symptoms of renal insufficiency, syphilis
may be, and probably often is, of great etiological importance.
The primary pathology is in the arteries and under that head-
ing a further discussion will be found.

Before leaving the subject of the effects on the kidney of
chronic infections and especially of tuberculosis and syphilis,
further mention should be made of amyloid disease of the kid-
neys. Always the result of chronic suppuration this condition
is a common accompaniment of chronic tuberculosis of the
lungs with cavitation and long-standing empyema or osteo-
myelitis. Syphilis and probably the mycoses, also produce
conditions favorable to the development of amyloid degener-
ation. Of course, with the recent advances in surgery, amyloid
disease is much less common today than formerly. It may,
however, develop with amazing rapidity, and its frequent oc-
currence in early middle life makes it of importance in the
present consideration.

Chemical Irritants. *Acute.* A large number of substances
are known to be irritant to the kidneys if taken into the diges-
tive tract or absorbed through the skin. Some, for example
uranium nitrate, are of value for the production of nephritis
experimentally in animals, but seldom if ever are the cause
of human nephritis. Others which may cause acute kidney

disease demand attention because of their employment in medicine, for example, copaiba, cantharidis, phenol, balsam of Peru, ether, chloroform, iodoform, naphthol, arsenic, and salicylic acid. In industry exposure to turpentine, glycerin or mineral acids is not an uncommon source of acute nephritis. Accidental or suicidal ingestion of corrosive sublimate is another frequent cause of severe and often fatal acute renal disease. This list is far from complete, but will serve the present purpose.

The following case is of interest in this connection. A boy twelve years of age, was admitted complaining of drowsiness, and swelling of face and ankles. For over two months he had been tired, listless and sleepy; and more recently he had lost his appetite and experienced epigastric pain. Several days before admission a severe frontal headache developed and he complained of vertigo, at the same time it was noticed that the urine was thick, cloudy and had a foul odor. The day before admission edema of the face was observed for the first time, and when first seen in the hospital his eyes were practically closed by the swelling and his ankles were also markedly swollen. The blood-pressure was systolic 145, diastolic 90 mm. Hg; the heart a trifle wide with a soft systolic murmur at the apex. The urine showed a fairly high specific gravity, 1.028, a trace of albumin, a variety of casts, and a few red, as well as white, blood cells. The phenolsulphonephthalein elimination was 67 per cent. in two hours, the blood urea nitrogen fifteen milligrams per one hundred cubic centimeters. The eye-grounds were normal. The picture was one of acute nephritis and the etiological factor was only discovered when further history was obtained. The boy had always had enuresis and for this his mother had been advised to administer "Haarlem Oil." This she did and unfortunately persisted in the use of this preparation for two or three months, giving two capsules each night, until about six weeks before admission to the hospital. "Haarlem Oil" is said in one formula to contain two parts in eight of oil of turpentine and it is probable that the unduly prolonged administration of this renal irritant led to the acute renal insufficiency. Complete rest in bed, a milk diet, and a series of sweat baths resulted in complete relief of symptoms, and the patient was discharged one

month after admission with no evidence of renal damage, either in the urine examination or by functional tests.

Mention has already been made in passing, of the contradictory evidence concerning the danger of injury to the kidneys by arsenic and mercury in the treatment of syphilis. There is some evidence that arsenic is most harmful if treatment with mercury has been extensively employed just previously, or if an acute nephritis from any cause has been present. Stokes has said, "that the cure or arrest of syphilis depends in an almost literal sense on the patient's kidneys."

It may be assumed that the degree of kidney damage produced by members of this general group of exogenous chemical substances is influenced not only by the dose and toxicity of the substance, but also by the health or susceptibility of the individual kidney. Age may well figure in this respect and there is experimental evidence presented by MacNider that with advancing years the injury suffered by the kidney from chloroform or ether increases, and that this increase is more or less proportional to the accumulation of lipoid material in the renal epithelium which occurs in the older animals. Finally it must be noted that individual toxic substances, both chemical and of infectious origin, may produce lesions limited to one part of the kidney structure; by one the glomeruli are especially damaged, by another the tubules. In some instances the damage is localized in one or more parts of the kidney as though the undamaged areas had escaped heavy exposure to the blood-borne poison, perhaps as a result of having been inactive at the time. Even pyelitis is said to result from some chemical irritants.

Chronic Exogenous Intoxication. As was said above the dose and toxicity of the irritant, at least in part, determine the reaction; so small doses may provoke no appreciable renal irritation or disease, but if such doses are often repeated a chronic lesion may develop. It is thus that chronic lead poisoning is supposed to bring about the chronic nephritis so often attributed to it. Alcohol seldom, if ever, initiates an acute nephritis, and there is not even any proof that its repeated use leads to the development of chronic renal disease. It has been suggested that alcohol acts only indirectly on the kidney by favoring infection from the intestinal tract. Much of its harmful

effects may ultimately prove to be exerted on the arterial system. Certain other substances, for example the salicylates and certain food adulterants, harmless in single dose, may perhaps act as does lead, over a long period of time, and bring about a chronic renal disease which would probably not make its presence known before middle age.

Chronic Endogenous Intoxication. Analogous to the action of chronic lead poisoning on the kidneys may perhaps be the effect of diabetes mellitus. Chronic nephritis is a very frequent complication or result of long-standing diabetes, especially in individuals of middle age or even older. What part in its pathogenesis is played by the hyperglycemia or glycosuria, or by the presence of ketones in the blood or urine, is not known. The widespread arterial disease in these individuals suggests that arterial change is an important element in the process.

Gout, although it is by some considered as a type or a result of renal disease, must also be mentioned as a possible cause of chronic nephritis. For many years the "gouty kidney" has been a recognized form of chronic nephritis, and the kidney lesion has been considered secondary to the disturbed purin metabolism or to its underlying cause. The direct reverse may, however, be correct. Absorption of toxic substances from the intestinal tract must also be kept in mind as a possible cause of chronic renal disease. The modern tendency, however, seems to be to belittle hypothetical toxic substances of intestinal origin.

Pregnancy. It has well been said that pregnancy is a searching test of bodily soundness. Not infrequently the kidneys fail to stand the test and so various degrees of kidney disease may appear during pregnancy. The term "kidney of pregnancy" is often employed of the mild cases of renal disturbance in order to avoid a diagnosis of acute nephritis. De Lee considers such mild cases "due to pre-eclamptic toxemia of very mild degree." In the more severe toxemia and in eclampsia more serious renal insufficiency may appear, but this kidney failure is the result of the toxemia, and primary kidney disease has little or nothing to do with the pathogenesis of the toxic state. Sometimes, however, the kidney element seems so marked that the term "nephritic form of eclampsia" is used.

True acute nephritis may develop during pregnancy and is predisposed to by the conditions bringing about the "kidney of pregnancy;" it is said to occur more frequently in youth, in the first pregnancy or after multiple pregnancies. On the other hand true acute nephritis or an increase of preëxisting nephritis occurs more often in women of middle age. Exacerbation of a chronic kidney disease is frequent during pregnancy and if uremic symptoms then appear the resulting picture will closely simulate eclampsia. The so-called kidney of pregnancy is said never to give rise to permanent change in the organ, but a true nephritis during pregnancy may undoubtedly produce serious and permanent damage. One cannot fail to be impressed with the frequency with which women date the onset of a chronic nephritis back to a kidney involvement in pregnancy. In such cases it is sometimes difficult to estimate with certainty the relative importance of various etiological factors. For example, one patient gave us a history of scarlatina with dropsy at the age of twelve years. At the age of twenty-four she became pregnant and went on to a normal delivery despite a marked albuminuria. She was admitted to the hospital two years later in the sixth month of a second pregnancy. At this time she had high blood-pressure, marked albuminuria, and all the evidences which would suggest a developing renal insufficiency.

Pyelitis is another renal disease which often appears or is aggravated during pregnancy. Its development is favored by the bacteriuria which is present in a large percentage of healthy pregnant women, and by the interference with the flow of urine down the ureter, especially on the right side caused by the enlarged uterus. The *Bacillus coli* is the organism usually recovered from the urine although a number of other organisms may occasionally be found. Sometimes a serious pyelonephritis is initiated, but as a rule the process is mild and no severe damage results from this complication of pregnancy.

INFLUENCE OF DISEASES OF OTHER ORGANS ON THE KIDNEY.

As one ages, isolated disease of a single organ becomes more and more uncommon. In youth the factor of safety in an organ is often sufficient to neutralize the harmful results of

disease in another part of the body. By the time middle age is reached this margin of safety is narrowed and disease of any organ is likely to lead to disturbance of function in several other organs. In considering, therefore, the disease of the kidney in middle life we must not fail to keep in mind the marked influence that may be exerted on renal function by disorders of other parts of the body.

Cardiovascular disease and the kidney are closely interrelated. Primary renal disease may result in disastrous effects on the myocardium, or both heart and kidney may be injured by the same cause. Mention has already been made of the important changes in the kidney which occur in bacterial endocarditis as a result of multiple bacterial emboli. It remains to be pointed out that changes in the circulation may bring about anemia, hyperemia or passive congestion in the kidney. Of these, passive congestion is of the greatest clinical importance, for it may seriously handicap the kidney's functional capacity and interfere with some of the tests of renal fuction. Prolonged passive congestion of the kidneys will lead ultimately to more and more widespread fibrotic changes in the organ with corresponding limitation of function. The nature of the cardiovascular disease producing the congestion does not seem to matter but British writers have emphasized the special frequency of nephritis in adults with mitral stenosis. Patients with syphilitic disease of the heart uniformly show some renal inadequacy but in a given case it is usually impossible to decide whether the syphilitic infection has acted on the kidney as well, or whether arterial disease or congestion due to circulatory failure is responsible for the renal disturbance. The effects of disease of the arteries and of changes in blood-pressure on the kidney belong more properly in the article on arterial disease.

Hepatic Disease. Cirrhosis of the liver and chronic nephritis are frequently found together, but it seems probable that a common cause is responsible for both. There is little justification for blaming the kidney disease on some hypothetical fault of metabolism arising from the liver disorder. It is true that one rarely sees marked jaundice unaccompanied by albuminuria, but information is lacking as to the severity of renal damage which can be caused by increased amounts of bile con-

stituents in the circulating blood. Chronic nephritis is also associated with polyserositis but this latter can scarcely be considered a primary hepatic disorder although the liver is so constantly involved. Hepatic enlargements may press on the right kidney or its ureter and so favor local infection, and ascitic collections are said to produce renal congestion, but these must be rare causes of kidney disease. On the left side an enlarged spleen may press on the ureter. In such a case our diagnosis of the splenic condition was confused by the demonstration by pyelography of a left sided hydronephrosis although the mass seemed to palpation to be a greatly enlarged spleen, and so proved at operation.

Pulmonary Disease. Except for the secondary results of such infections of the lungs as tuberculosis and pneumonia which have already been discussed there is nothing to be said.

Gastrointestinal Disease. Disorders of the esophagus and stomach bear little if any relation to disturbance of the kidney, but the intestinal tract is of great importance. It is the source of the causative infection in many cases of pyelitis, pyelonephritis and suppurative nephritis. This may be less uniformly true in adult years than in childhood when pyelitis is usually a complication of enteritis. Furthermore, severe diarrheal diseases, such as cholera, may produce serious kidney damage with extensive epithelial degeneration of the tubules, as a result probably of the action of powerful toxins presented to the kidney in concentrated form by the dehydrated blood. More hypothetical is the part played by the intestinal tract in the etiology of chronic nephritis; toxic end products of digestion are blamed by some, low grade infection arising from the intestines by others. At present there is no certainty.

Disease of the central nervous system has apparently only an indirect relation to kidney disease. Blood-pressure changes brought about by intracranial disease may influence the kidneys and their function. Disease of the nervous system may produce paralysis of the lower urinary tract and this in turn will have important effects on renal function which will be discussed shortly.

Endocrine Disorders. Although there are hypotheses which attribute to the ductless glands marked influence on the ac-

tivities of the kidneys and on the level of the renal threshold for various substances, yet there is little satisfactory evidence for these views. The pituitary may have important functions in controlling diuresis, and cessation of ovarian function may induce a climacteric hypertension which will favor the appearance of severe nephritic phenomena if the kidneys are susceptible or damaged, but despite such possibilities there is no evidence that any true kidney disease or renal insufficiency results directly from disturbances of the endocrine system. Neoplasms of the adrenal, especially hypernephroma, frequently involve the kidney secondarily.

Diseases of the Blood. Anemia, either secondary or primary, may if severe, bring about degenerative changes in the kidney parenchyma. These usually are of a fatty nature and do not result in fatal or even serious renal insufficiency. Tests of renal function in severe pernicious anemia are apt, however, to show a considerable depreciation from normal, but for this there may be extrarenal factors responsible. In leukemia the kidneys suffer both from degenerative changes and also from invasive deposits of myelocytic or lymphocytic cells according to the type of the leukemia.

Hemolytic processes resulting in hemoglobinemia and hemoglobinuria are said to bring about renal irritation, and if continued a nephritis may result. This group includes the hemoglobinuria of malaria and so-called "idiopathic hemoglobinuria," some cases of which are undoubtedly initiated by cold or excitement. Whether the nephritic changes which have been described as occurring in certain instances of purpura belong in this category or whether more direct damage is done to the kidney by the purpuric phenomena, is not known. Sometimes a single cause, for example, poisoning by potassium chlorate, may be responsible for a combination of purpura, hemoglobinuria and nephritis.

Cutaneous Disease. Burns of the skin are a frequent cause of acute nephritis but it is not clear whether the kidneys are injured by toxic substances absorbed from the area of damaged tissue or whether secondary infection is the important factor. In some cases the renal trouble may be due to the hemoglobinuria which forms part of the picture. It is equally difficult to be sure of the manner in which chronic diseases of the skin,

such as eczema and pemphigus, come to have kidney changes so often associated with them.   Erysipelas is an important cause of acute nephritis and even eczema may be accompanied by such a result.   Erythema and urticaria, as seen for example in serum disease, have both been described as bearing some causative relation to kidney disease or at least to temporary disturbances of renal function, and it has been assumed that there is in such cases a general disturbance, of which the skin phenomena and the renal symptoms in common were manifestations.   Idiopathic purpura has for some time been recognized as having associated with it the evidences of an acute nephritis.   A persistent hematuria has been observed in some cases.

Disorders of the lower urinary passages in two ways chiefly, may harmfully influence the kidney.   Obstruction to the outflow of urine by prostatic hypertrophy for example, or by stricture, stone or pressure on the ureter, or by sphincteric spasticity may produce hydronephrosis and will predispose to infection of the kidney pelvis.   Furthermore, obstruction of even moderate degree produces back pressure and interferes sometimes seriously with the functional ability of the kidney. This is clearly seen in patients with neurological troubles and in men with hypertrophy of the prostate.   If the obstruction is so placed as to effect both kidneys, as it usually is, then kidney function may be so reduced as to lead to a marked retention of urea in the blood and even to uremia and death.   If the obstruction is relieved renal function may be restored to a remarkable degree in many instances thus indicating that the renal insufficiency is more a matter of extrarenal mechanical factors than due to a definite anatomic change in the kidney.

Infection of the lower urinary passages may ascend and involve the kidney, but this occurs less often than was formerly believed.   The majority of the organisms which infect the kidney reach it in the circulating blood.   Occasionally infection of the lower urinary passages causes ureteral obstruction, and then the two factors may combine to produce damage of the kidney.

SYMPTOMATOLOGY OF DISEASES OF
THE KIDNEY.

In middle age the symptoms of kidney disease differ but little from those seen in youth or age; a great variety may appear, some only rarely, others with varying frequency in the different age groups. This changing prominence of certain symptoms at different ages is to be explained in part on the age incidence of certain diseases of the kidney, and in part on a narrowing margin of safety. Thus certain manifestations of renal insufficiency are commoner in the kidney disease of middle age than in that of youth; uremia is relatively rare in juvenile nephritis, it is common in adult years. A marked grade of hematuria on the other hand is a more evident symptom of nephritis in childhood than after the age of twenty. Also in middle age the symptomatic picture is often confused by the presence of symptoms whose origin rests in an inconspicuous failure of the circulation or of hepatic function. The symptoms of disease of the kidney in childhood are those of purely renal origin plus those arising from the unstable nervous system of youth; in middle age a number of other organs may by the failure of their function add symptoms to the picture.

The variety of symptoms which may arise in disease of the kidney is enormous and each form of renal disease has certain symptoms more or less peculiar to itself. To emphasize this diversity of symptomatology the following list is given; it consists of the chief complaints of two hundred consecutive cases of nephritis of all varieties. Edema was the chief complaint in thirty-four cases; dyspnea in twenty-eight, headache in twenty-four, weakness in twenty-two, disturbed vision in fourteen, convulsions in eleven, pain in the back in ten, and vomiting in nine. Albuminuria and thoracic pain were given as the chief complaint by eight patients each; abdominal pain by six, "out of sorts" by three, indigestion by three. Palpitation, drowsiness, epistaxis, cough, and vague pains were each the foremost complaint in two cases, and nausea, dizziness, dysuria, aphasia, "mental change," hematuria, insomnia, enuresis, melena, and spasm of jaws each in one case.

In a rough way all symptoms of kidney disease can be divided into those of the disease itself and those resulting from or associated with, a renal insufficiency due to the renal damage. The group of symptoms not resulting from kidney insufficiency is surprisingly small and perhaps should be even smaller than our present knowledge makes it. It includes chiefly the symptoms of actual infection of the kidney, of stone, of cystic disease and of neoplasm. These symptoms are in a sense more obvious and less important than the larger group arising from disturbance of one or other of the kidney's functions. The symptoms of nephritis almost all fall in this latter group.

SYMPTOMS NOT RESULTING FROM KIDNEY INSUFFICIENCY.

Urinary Changes of Renal Origin. *Albuminuria* may appear in the absence of any demonstrable interference with renal function and in fact without any appreciable anatomic change in the kidney. It, therefore, cannot be considered as always a symptom of kidney disease. Such albuminuria unassociated with any evidence of renal change has been described under various names, for example, physiological albuminuria, adolescent albuminuria, orthostatic or orthotic albuminuria. In this latter form various factors have been said to play a part; posture, a familial tendency, muscular exertion and cold baths are among the list of exciting causes. This type of albuminuria apparently does not predispose to kidney disease, and tends to disappear as middle age is reached. The same is true of the albuminuria developed by certain individuals after the eating of certain proteins. Also there is evidence from life insurance statistics that so-called adolescent albuminuria does not lead to nephritis in later years. All of us are subject to an insignificant albuminuria after violent exercise.

On the other hand we must not fail to admit the possibility that despite some evidence to the contrary, the albuminuria which occurs during fever, the so-called febrile albuminuria, indicates some true renal disease which may be so mild as to be unrecognizable by our present methods. The reverse is certainly true, that obvious anatomic changes such as fatty

degeneration may be present in the kidney without the escape
of albumin into the urine.

It is easy to say that the presence of albumin in the urine
is due to an abnormal permeability of the renal tissues to the
blood proteins but it is not known how this occurs, nor what
part of the kidney unit permits the passage of the protein.
Circulatory disturbances, especially passive congestion, of the
kidney readily produce albuminuria and various types and de-
grees of nephritis commonly exhibit it. But it is not safe to
draw conclusions as to the extent of the anatomical change in
the kidney from the quantity of albumin in the urine. Nor can
any estimate of renal function or of renal insufficiency be based
on the degree of albuminuria. As a rule it is greater in acute
than in chronic nephritis; but it is impossible to draw con-
clusions of any kind concerning the state of the kidneys from
the discovery of an albuminuria alone. On the one hand it
may be of the so-called physiological type and yet be fairly
large in amount, quite continuous, and even accompanied by
an occasional hyaline cast; on the other hand it may be the
result of a severe chronic nephritis and yet be slight in amount,
intermittent and with few associated signs or symptoms. Al-
buminuria alone is a poor guide in diagnosis, prognosis or
treatment.

Albuminuria in middle age, however, should always be con-
sidered an evidence of disease of the kidneys, probably a
chronic nephritis, unless careful investigation has proven
otherwise. Passive congestion must not be overlooked and
one must always exclude other causes such as the admixture
with the urine of spermatozoa, blood or pus, also one must
differentiate the occasional case with Bence-Jones protein in
the urine.

Casts in the Urine. Much the same arguments apply to the
finding of casts in the urine. Often they are found, especially
the hyaline variety, in the urine of individuals in whom no
other evidence of disease of the kidneys can be recognized and
who continue in apparently perfect health for many years.
Undoubtedly some weight must be given to the repeated find-
ing of hyaline casts in the urine, but it is difficult to say just
how much. Casts of other varieties especially epithelial and
other cellular casts have a greater significance and speak more

clearly of the local conditions in the kidney.   Acute nephritis leads to the presence of many casts in the urine, but chronic nephritis with edema is the renal disease giving the greatest number and variety, and it is rare for casts to be absent from the urine in these conditions.   Sometimes the casts may be difficult to find on account of an associated hematuria of even moderate degree.   It may be that casts and hematuria do not occur coincidently, or perhaps the presence of the blood causes the disappearance of the casts by disintegration or solution. Certain it is that casts rapidly disappear from an actually alkaline urine.   In chronic nephritis without edema, casts are usually present in the urine but may be absent from one or more separate specimens.   Occasionally they are found in the absence of albuminuria.

In youth the finding of kidney casts in the urine may be of the most importance or of only trifling significance, but in middle age their discovery is more constantly indicative of permanent kidney damage.

Hematuria is another urinary change which may occur independently of alteration of kidney function, and from a diversity of causes.   We are not concerned here with any but renal hematuria, nor do such causes as trauma to the kidney, stone in the kidney pelvis, purpura or anemia need but passing mention.   Obviously the many causes of bleeding from the ureter, bladder or urethra are outside the present consideration.

Renal hematuria may be induced by a variety of disturbances of the circulation of the kidney, as for example thrombosis of the renal veins, embolism and infarction, varices or telangiectases, aneurism of the renal artery, arteriosclerosis, and chronic passive congestion.   It may also appear in acute or chronic nephritis, in tuberculosis, syphilis, tumor, and polycystic disease of the kidney.   It is not an uncommon finding in pyelitis or pyonephrosis but is rare although occasionally present, as a result of hydronephrosis or movable kidney.   In these latter the hematuria may have the same explanation as is given for the bleeding which occurs after sudden relief of distention of the bladder.   Hematuria occurs occasionally during pregnancy and lactation, and finally there occur instances of renal hematuria, usually unilateral in origin for which no cause can be discovered.   To these the terms idio-

pathic or essential renal hematuria have been applied, and it
has been suggested that a focal nephritis may be responsible,
or that the bleeding should be considered a prenephritic symp-
tom. In many severe infectious diseases and in a variety of
chemical poisonings hematuria may occur from the renal
hyperemia which appears early in the acute nephritic process.

In acute nephritis, especially in children, hematuria is a
prominent symptom, it is seldom absent and usually propor-
tional to the severity of the attack. This has led the pedia-
tricians to speak of hemorrhagic nephritis. In acute nephritis
in middle age hematuria is probably just as constant, but the
blood is by no means so abundant as a rule. In chronic nephri-
tis hematuria is less common, although a more or less periodic
gross hematuria, sometimes of considerable amount, may ap-
pear in cases with high blood-pressure and arterial disease.
Still another type of renal bleeding may be seen occasionally
in terminal chronic nephritis; in these instances the renal
bleeding may be one manifestation of a general hemorrhagic
tendency or symptomatic purpura associated apparently with
the uremic toxemia.

Perhaps in no condition is the discovery of a microscopic
hematuria so likely to be the only evidence of renal involve-
ment as in bacterial endocarditis. In such cases the repeated
finding of a few erythrocytes in the urine is good evidence of
the multiple emboli which are lodging in the renal glomeruli
and there setting up a process which, if the patient survive
long enough, will bring about sufficient damage to produce
true kidney insufficiency, sometimes with a fatal outcome. In
tuberculosis of the kidney also, hematuria may for some time
be the only symptom, but gross hematuria from renal tuber-
culosis is rare except in the so-called tuberculous papillitis.
The possibility of a focus of early tuberculosis in one kidney
is not to be overlooked in the study of a case of hematuria,
even if the patient be of middle age. Although renal tuber-
culosis is probably more common in youth because of the fre-
quency, at that age, of the miliary form yet on the other hand
so-called surgical tuberculosis of the kidney is quite as fre-
quent, if not more frequent, in middle age than in youth.

Pyuria of renal origin is usually the result of one of the fol-
lowing conditions; pyelitis, pyelonephritis, pyonephrosis, ab-

scess or tuberculosis of the kidney. Pyuria does not occur with renal calculus unless as is frequently the case, infection has developed secondarily. Nephritis does not as a rule lead to the presence of many leucocytes in the urine, although in some cases a constant mild pyuria may be found in the absence of any demonstrable infection of the kidney pelvis. The types of nephritis most apt to be associated with pyuria are the acute forms and the chronic variety with considerable edema. In some of these latter cases the pyuria may be of sufficient amount to suggest strongly that active infection is present in the kidney. The cells are usually polymorphonuclear leucocytes, and the emphasis laid by the older writers on the frequency of lymphocytes in the urine of acute nephritis was probably exaggerated. In pyelitis an amazingly large amount of pus may be passed, but the largest quantities occur as might be expected in pyonephrosis, although in this condition for short periods the urine may be almost free of pus. This is important to remember as these periods of normal urine are apt to coincide with exacerbations of symptoms.

Bacteria are often found associated with pus in the urine. Pus without bacteria should suggest tuberculosis of the kidney. The reverse may occur, as for example, the bacteriuria of typhoid fever, at which time enormous numbers of typhoid bacilli may be present with few or no cells, unless as in one unusual instance endothelial cells are found.

Although fever and leucocytosis are not uncommon in renal infections, it must be noted that marked pyuria may occur in the absence of both fever and increase of circulating leucocytes.

Disturbances of Urination. These, when they are truly of renal origin, are as a rule related to increase or decrease in kidney activity, sometimes physiological in nature. This is not the place to discuss the causes of polyuria or oliguria; they will be referred to later. Sometimes, however, disturbances of urination may be reflex to disease of the kidney, and this is a frequent occurrence when there is much kidney pain as for example, in renal colic. Frequency of urination is then the rule. Perhaps frequency of urination in renal disease may be a result of the secretion of an irritating urine.

Local Renal Symptoms. *Pain* may be entirely absent throughout the whole course of a serious kidney disease, as

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for example tuberculosis or nephritis. The frequency of its presence in nephritis, while considerable, has been greatly exaggerated, especially by the laity. Among the group of 200 cases of nephritis of all types pain in the back was given as the chief complaint in only 10 cases, and it was mentioned by not many more. The severity of the pain in nephritis has also been exaggerated, and as a rule it is little more than a feeling of heaviness or weakness. In acute nephritis it may be more severe and is probably due to swelling of the kidney from local hyperemia and edema.

On the other hand pain, apparently of renal origin, may occur in the absence of all demonstrable kidney lesions, and to these cases the unsatisfactory term nephralgia has been applied. In some instances this type of kidney pain is said to be associated with "idiopathic" hematuria, and is possibly the result of local congestion. True renal pain, as with calculus, may be extremely severe and localized over the affected organ; frequently it is referred down the line of the ureter to the ovarian region in the female and to the testis in the male, occasionally the pain extends down the leg. No satisfactory explanation has been advanced for the occasional occurrence of pain partly or wholly on the side opposite to the affected kidney. In a personal observation an enormous renal calculus on the right side produced severe and characteristic pains on the left side. So striking was this location of the pain that a second roentgenogram was insisted on before surgical operation was undertaken. Complete relief of pain followed the removal of the right kidney.

Renal pain may be continuous and may remain fixed in the back or in front over the crest of the ilium. Recently emphasis has been laid on the frequent occurrence, as a result of disease of the kidney or ureter, of pain in the upper abdomen or near McBurney's point on either side. Calculus may produce such fixed pains, which are usually made worse by jolting or exercise, and may be increased by apprehension or worry.

Renal colic differs from the above type of renal pain by its paroxysmal nature, its tendency to greater severity and more frequent reference down the course of the ureter. Colic is commonly thought of as the result of kidney stone, but equally severe and characteristic renal colic may be a symptom of

hydronephrosis, movable kidney or tuberculosis of the kidney, and may result from any renal hematuria. There are wide variations in individual attacks; the pain may be very mild or intensely agonizing, in one attack it may be referred down the ureter and in the next remain localized over the kidney. Its duration may range from a few minutes to several hours. Vomiting, dizziness and syncope are not infrequently associated with severe attacks.

Local tenderness is often marked for several days after renal colic, and on deep palpation one may often elicit tenderness of the affected kidney. Tenderness in nephritis is extremely rare except perhaps in the acute stages.

Enlargement of the kidney of sufficient degree to be recognizable on physical examination results from neoplastic disease, hydronephrosis, polycystic kidney and abscess; the relatively moderate enlargement incident to nephritis is seldom demonstrable. As a rule the enlarged organ pushes posteriorly rather than forward, but many variations occur. The posterior position of the organs makes it possible amazingly often to recognize even a moderate enlargement by careful inspection of the loins with the patient sitting upright in a bright light. By bimanual palpation it is usually the posterior hand which most clearly feels the solid mass of the kidney and in many instances the organ can be readily recognized by its shape, position and movability. At other times it is a matter of extreme difficulty to differentiate between an enlarged kidney and an enlarged spleen on the left, or gall-bladder or Riedel's lobe of the liver on the right. The difficulty is increased by the loss of shape which occurs with many of the enlargements of the kidney. In congenital polycystic disease of the kidneys, however, the individual cysts can sometimes be recognized, and if the condition is bilateral, diagnosis by palpation alone is not difficult. When the renal enlargement is due to active infection, as in perinephric abscess, the mass can, as a rule, not be outlined, some subcutaneous edema may be present in the loin, and the skin may be reddened. Percussion is of little value in the recognition of renal enlargements. Roentgenograms will often reveal the size and shape of the kidney, and may be of greater value if pyelography or pneumoperitoneum is employed.

SYMPTOMS RESULTING FROM, OR ASSOCIATED WITH KIDNEY INSUFFICIENCY.

As a preliminary to a discussion of kidney insufficiency it is necessary to review, at least briefly, what is known about kidney function and the manner of its disturbance.

Kidney function, considered from a broad point of view, is concerned with the maintenance at the normal level of the composition of the circulating blood. This implies two actions; first the ridding of the blood of any abnormal substance or of any abnormal accumulation of a normal constituent, and second the preservation to the body of the normal constituents of the body fluids, at or near their normal levels. All of the substances excreted or barred from excretion by the kidney are presented to it by the blood already formed, with the one exception of hippuric acid. Thus the kidney acts almost solely as a regulatory mechanism and in its action responds with amazing sensitiveness to the stimulus of altered blood composition and of altered blood flow.

Of the substances excreted by the kidney there are two main groups; the first composed of those substances which are apparently of no further use to the organism such as urea, uric acid, ammonia and substances foreign to the body, such as dyes and medicines. To this group Ambard has applied the term excrementitious. The substances of the second group, including sodium chloride, glucose and perhaps water, are still capable of being utilized by the body, and it is, therefore, habitual for a certain content of them to be retained. Toward these two groups, as might be expected, the kidney acts differently. It continues to rid the body of the so-called excrementitious substances, the members of the first group, so long as any remain in the circulating blood, and at a rate probably in direct relation to the amount in the blood. In reacting toward the second group however, the kidney only commences to excrete these substances when their content in the blood has exceeded the normal level. It is this fundamental difference in kidney reaction which has led to the application of the term "threshold substances" to the second group; and the term "substances without threshold" to the excrementitious substances of the first group. It is this so-called threshold

which preserves the physiologic constituents of the bodily fluids at their normal level, but it is not known whether the mechanism of the threshold resides in the kidney or in the physical chemistry of the body fluids themselves, or in a combination of both. Nor is it known what determines the level at which these threshold substances are found in the blood. Macallum has suggested that the level of inorganic salts in the blood may represent unchanged the salt content of the ocean at the time when the forms of life from which we are descended left the ocean and assumed, at least in part, a terrestrial existence. Whatever determines the normal threshold in health it is certain that it can be markedly altered by disease of the kidney, and perhaps by disturbance of the endocrine system or body chemistry. In the case of kidney disease there will occur no change in the composition of the blood from this cause so long as kidney compensation exists. The kidneys have a wide margin of safety as is evidenced by its being possible to remove one kidney without provoking renal insufficiency. It is obvious, therefore, that kidney disease may exist for some time without the accumulation in the blood of the excrementitious substances of the first group and without raising the blood's content of the substances of the second group above the normal level. In middle age, however, the margins of safety are narrower than in youth, and kidney disease sooner brings about renal insufficiency.

Recent investigations by Richards have shown that there is a marked intermittency in the activity of individual glomeruli or groups of glomeruli. Apparently not all are active at one time under normal conditions nor are those which are active equally so. Perhaps this constitutes part of the factor of safety in the kidney; a reserve force of inactive glomeruli ready to become active under conditions of exceptional functional demand. In measuring renal function also we must admit the possibility that the kidney may have available more excretory units than are at the moment functioning. Erroneous results might thus be obtained unless the test were one which called forth full functional capacity on the part of the organ.

Once, however, disease of the kidney has raised an essential threshold or has interfered with the kidneys' excretory func-

tion, then renal insufficiency tends to develop and alteration in the composition of the blood to occur. Substances belonging to either group may accumulate in the blood as a result of kidney disease. Sometimes it will be the excretion of the end-products of nitrogenous metabolism which will be especially interfered with, or again it may be that the renal damage will be associated with retention of water and sodium chlorid in the body, or with disturbance of the acid base equilibrium. In each of these instances the clinical picture will vary; often it is a combination of them all. Different types or stages of kidney disease may interfere with different kidney functions and the interference may vary in degree. There is some evidence that the kidney lesion may produce so limited a disturbance of function as to interfere with excretion of but a single substance. This is said by some to occur early in some cases of nephritis, and the hypothesis has been advanced that gout is the result of such an early nephritic change interfering exclusively or predominantly with the excretion of uric acid.

In addition to the extent of renal damage several other factors will quantitatively influence the results of impaired renal function. The demand made by the body on the impaired function will play a part, and secondly the ability of the body to assist the damaged kidney by excretion through other channels, the skin, bowels and lungs. Here we touch on the principles of the treatment of renal insufficiency under which heading this aspect of the subject will be referred to again. Symptomatically the clinical picture will be composed in part of the disturbances from retention which will vary in nature and degree in different cases, and in part from truly extrarenal factors. Symptoms in kidney disease can not be assigned to any one form of renal disease; some arise locally in the kidney, others are the expression of the renal insufficiency of function, and still others are the evidence of widespread disturbances, extrarenal as well as renal. A given group of symptoms may be found to be associated with either one of several pathological conditions of the kidney.

While it is undoubtedly true that the component parts, the glomerulus and the tubule, of the renal excretory unit have distinct functions, and that certain forms of nephritis involve particularly one part or another, yet our ignorance of the func-

tions of the individual parts is still so great, and the coincident, though perhaps unequal involvement of the various parts is so constant that we are usually unable to correlate symptoms, disturbed function and kidney lesion. Damage to one part of an excretory unit probably incapacitates the whole unit; a glomerular occlusion renders the corresponding tubule functionless.

Richards has added strong support to the filtration theory of glomerular activity. It is the chief structure concerned in the renal elimination of fluid from the blood and it acts mechanically in response to change in intraglomerular pressure, which in turn is regulated by the arterial pressure and by the relative degree of constriction or dilatation of the afferent and efferent vessels of the glomerulus. The vascular relations in the kidney all favor a relatively high blood-pressure in the glomerular tufts, and the fact that the vessel leaving the glomerulus is smaller than the afferent vessel also aids in this respect. This difference in caliber of the glomerular vessels also permits small doses of vasoconstrictor substances to bring about an increase in intraglomerular pressure by acting more effectively on the smaller efferent than on the larger afferent vessel. It can also be seen that any blood-borne vasodilator substance which in part passes out of the blood in the glomerular filtrate must be potentially a diuretic, for its effective concentration tends to be greater in the blood in the afferent than in the efferent vessel with a consequent rise in intraglomerular pressure.

Less definite is our knowledge concerning tubular function. It has been held that in the tubules absorption takes place especially of the threshold substances, it being supposed that these have been filtered out of the blood in the glomerulus and are saved for the body by reabsorption in the tubules. Not all, however, accept the reabsorption hypothesis of tubular function; and some believe that the best evidence is for a combined reabsorption and excretion by the tubules. At any rate there is good evidence that tubular activity, whether it is reabsorption or excretion, is an "active" process in that the cells of the tubules utilize oxygen in proportion to their activity.

On these facts and hypotheses it is obviously difficult, if not impossible, to correlate anatomical change, disturbed function

and clinical picture. We must await further investigation, and in the meantime admit our ignorance.

Let us now consider the more important of the symptoms associating themselves with renal insufficiency.

Polyuria. The normal kidney responds with an increased secretion of urine to a variety of causes including a free ingestion of water, salts or caffeine; to nervousness, fright or cold, and during the elimination of an edema, etc. Polyuria also occurs in diseases apparently not involving the kidney, such as diabetes insipidus and diabetes mellitus. In the former the pituitary probably is the seat of the primary disorder, and little is known of the mechanism bringing about the polyuria; a hypothetical lowering of the renal threshold for water, if there is one, has been suggested. In diabetes mellitus the polyuria is usually proportionate to the glycosuria, although it may persist to a lessened degree for some time after the urine becomes sugar free, or may antedate a return of obvious glycosuria. As a symptom of kidney disease polyuria occurs chiefly in chronic nephritis, in which condition it may be the first, and for some time the only symptom. It seldom reaches such a degree as would cause complaint except for the fact that the polyuria may be at its height during the night and so interrupt sleep. Furthermore the frequency of urination may be in excess of the increase in urinary quantity. Such frequency may perhaps be explained on an irritating quality of the urine, for although in the chronic nephritis of which polyuria is a symptom, the urine is characterized by a pale color, low specific gravity and small amount of albumin yet an altered hydrogen ion concentration may be the responsible factor. The low concentration of the urine is not the result of the polyuria but rather of diminished kidney function. In chronic nephritis especially the type without edema, one of the early alterations in function is a loss of the ability of the kidney to concentrate the urine, or, in other words, to excrete concentrated urine. In such cases the polyuria may be a compensatory reaction in an effort to maintain at normal the necessary daily excretion of solids. Similarly the damaged kidneys fail to reduce as promptly as normal the beginning accumulation in the blood of the metabolic end products, and so continued kidney activity during the night is required. This is the prob-

able explanation of the nocturia of chronic nephritis, but in a given case many factors enter into the question, and perhaps too much emphasis has been given in the past to the significance of an increase in the night urine as an evidence of renal disease or insufficiency.

Thirst is commonly associated with polyuria, and the older writers, Bartels for example, considered the polyuria a result of the increased fluid intake which the thirst demanded. It is more probable that if either is primary it is the polyuria, and that the thirst results from the depletion of the store of water in the tissues. Only by an increased fluid intake can the necessary polyuria be maintained. In final analysis, however, both are results of the disease and neither will exist without the other. Increased blood-pressure is usually present in the cases of chronic nephritis with polyuria, but the degree of hypertension and of polyuria are not proportional and the relation of one to the other is far from clear.

Polyuria may also occur in pyelitis and in renal tuberculosis, but one may often erroneously assume its presence, misled by the frequency of urination. By this error the kidney may be suspected while the trouble is perhaps in the prostate or bladder. Measurement of the 24 hour urine is the only sure way of avoiding this mistake.

Anuria and Oliguria. Removal of all functionating renal tissue results in anuria and death. This has occurred from the removal of a patient's single kidney at operation for calculus or other disease, and emphasizes the importance of making sure of the presence of a second functionating kidney before proceeding to nephrectomy. Anuria also occurs from calculus obstruction of both ureters or from occlusion of one ureter with reflex suppression of excretion by the other kidney. Similarly injury or operation on one kidney may cause a complete reflex anuria which may last several days or even a week or longer. In acute nephritis, as, for example, from mercuric chloride poisoning, anuria due to suppression may persist for ten days or more with ultimate restoration of function and recovery. In one case of severe bichloride of mercury poisoning with suppression and all the evidence of severe renal insufficiency, recovery occurred and the patient, several months pregnant at the time of the poisoning, passed through the rest of the

pregnancy uneventfully and gave birth to a healthy child.
Also in states of extremely low vitality with greatly lowered
blood-pressure the excretion of urine may for considerable
periods be extremely low.

It is difficult at times to diagnose promptly the cause of a
sudden suppression. Calculus should be thought of first, and
one should regard with skepticism a diagnosis of chronic neph-
ritis as the explanation of anuria. Rarely does chronic neph-
ritis produce this result, more often an unrecognized calculus is
present; this simulation of chronic nephritis by renal calculus
is not adequately appreciated.

Some instances of complete or almost complete suppression
of urine which have persisted for twenty or thirty days, offer
interesting points of contrast with uremia from nephritis.
In these cases the accumulation of urea, creatinin, etc., in the
blood may rise far higher than in most cases of uremia, and
yet the patient will fail to present the characteristic uremic
picture. The mentality will remain clear, there is no diar-
rhea, and but little vomiting or edema. Relief of the kidney
disease by operation or otherwise, usually results in prompt
improvement with rapid return to nearly normal of the com-
position of the blood. Even after four weeks of almost com-
plete suppression recovery may take place.

Oliguria is the rule in acute nephritis of almost every
variety, and is also the result of passive congestion of the
kidneys; in general any condition resulting in edema will at
least temporarily be associated with lessened excretion of
urine. In acute nephritis the oliguria may precede the appear-
ance of the edema by several days, but daily weights would
reveal the retention before the edema became visible. In
other instances the edema may apparently antedate any cut
down in urinary quantity. With the decrease in the amount
of urine the specific gravity usually rises, the color becomes
deeper, albumin and casts increase, and large numbers of
erythrocytes and leucocytes may appear in the sediment.
Merely from concentration the urine may become irritating
and lead to frequency.

Edema. Hippocrates observed that a diminution of urinary
secretion was a cause of dropsy, and Bright established the
causal relation between kidney disease and dropsy but un-

fortunately we must admit that the whole question of edema is still far from clear. There are those who attribute the dropsy of kidney disease to the failure of the kidney to eliminate, some say water, others salt. In direct opposition is the view that either water or salt is primarily retained in the tissues. Some emphasize the loss of albumin as an underlying factor; others a primary damage of the endothelium of the vascular system. Still others see the explanation in a disturbed acid base equilibrium or in an abnormal state of the colloids of the body. Finally a hypothetical toxic substance has been suggested. Apparently valid objections are raised to each theory and none seems to meet all the requirements. There is no doubt that with the development of edema urine secretion is diminished and fluid is retained; and in the majority of instances salt as well. But retention of salt does not always lead to edema, nor does a low salt diet always remove edema, and experimentally neither an excess of salt alone nor of water will bring about an edema. Three factors were found by Pearce to be necessary: A kidney injury, a vascular endotheliotoxin and an excess of water. Both salt and water play a part in the production of edema in man but it may well be secondary to some more important primary factor. Futhermore, it is impossible to correlate the degree of the edema with the severity or the extent of the kidney lesion, or with other evidences of impaired renal function.

Edema of renal origin as a rule first appears and chiefly localizes in the loose subcutaneous tissues of the eyelids or of the prepuce, scrotum or labia. This characteristic is said to become less marked as age advances. Occasionally the edema of kidney disease is first observed in the ankles, or if the patient has been in bed, in the dependent parts, the buttocks, thighs or back. In some instances renal edema appears to be markedly influenced by gravity, as circulatory edema usually is, in other cases it seems not to be. As a rule edema in kidney disease is first discovered in the morning in the eyelids or face, and this swelling may be extremely fugacious, it may disappear by noon, to reappear before night in the ankles or perhaps the back of the hands. Sometimes with little or no warning a rapidly increasing general dropsy will develop. More rarely edema appears in unusual sites, determined per-

haps by local deformity or disease. For example a young man
was recently admitted to the hospital with marked bilateral
edema of the loose tissues of the neck. This proved to be the
first evidence of an increasing generalized edema associated
with a nephritis. There was an extensive tuberculosis of the
larynx present.

Once extensive edema has developed the swollen subcutane-
ous tissues pit readily on pressure and seldom exhibit the
brawny induration so common in the chronic edema of cir-
culatory disease. Over the swollen areas the skin becomes
stretched and glassy, and may crack and weep serum copiously,
sometimes with amazingly beneficial results. After the sub-
sidence of a marked edema the skin may show striæ like those
following pregnancy. The dropsy associated with renal dis-
ease may go on to anasarca; the eyes are closed by the swol-
len lids, the facies altered to the so-called frog face, the pre-
puce sufficiently swollen to cause great difficulty in urination,
the scrotum ballooned out to many times its normal size,
the arms and legs almost too heavy to be moved.

Dropsical collections in serous cavities are less common
early in edema associated with disease of the kidney than in
circulatory disease with an equal degree of subcutaneous
edema. However, as the edema in renal disease becomes more
marked ascites is fairly constant, and is sometimes quite out
of proportion to other manifestations of the edema, perhaps as
a result of unsuspected passive congestion or disease of the
liver. Hydrothorax comes next in frequency and then peri-
cardial effusion. The edema may involve any organ of the
body and so a great variety of symptoms may arise. The men-
tion of a few will be sufficient. Headache and stupor may
result from edema of the brain; dyspnea, sometimes of fatal
severity, from edema of the larynx, glottis or lungs; digestive
disturbances and diarrhea from edema of the gastrointestinal
tract. Circulatory embarrassment may develop from the gen-
eral edema or as a result of hydrothorax or pericardial effusion.
It is not certain that all of these symptoms are the result sim-
ply of the edema, and this point will be discussed again later.

There is often confusion between the edema of kidney dis-
ease and that of circulatory failure. Especially in patients no
longer young myocardial weakness is apt to be present in the

later stages of a chronic nephritis, and frequently leads to edema of circulatory origin. This may occur alone or both types of edema may be combined, in which case it is often difficult to properly evaluate the two factors. In treatment it is important to keep this possibility in mind; many symptoms may be mistakenly blamed solely on kidney disease whereas an important circulatory factor may also be present. For example, cerebral symptoms commonly said to be uremic, may unqestionably at times result from disturbances of the cerebral circulation, sometimes with local edema.

Edema is one of the cardinal symptoms of nephritis; it occurs in almost every case of acute nephritis and in many instances of the chronic type; in fact Christian and others employ its presence or absence as the criterion for dividing chronic nephritis into two varieties. Middle age supplies a relatively small number of cases of acute nephritis, and edema becomes more and more infrequent and less marked as old age approaches, yet at any age the appearance of an edema suggesting that of renal disease should direct one's suspicion first to the kidney.

Of the non-nephritic diseases of the kidney which may cause dropsy all of the important ones have been touched on in the discussion of anuria and oliguria, and in this group the edema seems perhaps to be more clearly related to deficient excretion of water.

Uremia. Mention has been made in discussing anuria of the difference between the symptomatic picture in anuria and in uremia. While it is true that certain instances or, as some would have it, types of uremia come very close to the symptom complex resulting from anuria, yet from this latter picture the convulsive seizures, amaurosis and transient palsies or hemiplegia which are so common in uremia, are usually lacking. By some these differences are considered sufficient proof that uremia is not simply a result of the retention of toxic substances normally excreted by the kidneys. Moreover, as Foster in a recent Harvey Lecture has pointed out, there are fundamental differences in the two processes. Anuria develops abruptly and the associated retention of water lessens the concentration of any harmful substances in the tissues; uremia may result from slow accumulation in the body of toxic mat-

ter whose concentration is increased by the loss of water which the associated polyuria entails.

On the other hand, it is quite possible and there is some evidence to suggest it, that uremia may depend upon some extrarenal factor; perhaps, for example, a disturbance of hepatic function brought about either by the noxus which primarily caused the kidney disease, or by the results of the disease directly or indirectly. From this point of view the term nephritis would be used to include the whole disease picture with pathological changes involving perhaps several organs in addition to the kidneys, for example the arterial system or liver. Such a view would then include uremia and dropsy among the symptoms of a kidney disease such as nephritis, but would not accept them as evidences necessarily of renal insufficiency or disturbed renal function.

To the type of uremia which resembles the picture resulting from anuria the term asthenic uremia has been applied and a similar picture can be produced in animals by feeding high doses of urea. Differing markedly from this type the so-called epileptiform uremia would seem to be due to a different causative factor. Other divisions of uremia have been advocated; Volhard gives the following: (1) Acute or eclamptic form, so-called "false uremia," which he believes may occur without any evidence of renal insufficiency. (2) True chronic uremia, which never occurs except with renal insufficiency. (3) Chronic pseudo-uremia. Notwithstanding these attempts to subdivide uremia it seems better to discuss the subject as a whole and to consider these so-called types merely as variants of one condition. In at least some cases the toxic substance isolated by Foster from the blood of uremic patients may well be the responsible agent, and whether or not this special substance is always present we can feel fairly sure that directly or indirectly retention plays a part in the pathogenesis of uremia. One is justified in saying with Dieulafoy, "I fear less that which passes out than that which does not pass."

Christian defines uremia as the toxic manifestations of renal insufficiency, in particular those that arise from disturbances in the central nervous system. This is a broad definition and, in our ignorance to-day, permits us to class under the terms toxic or uremic, almost all of the symptoms of renal insuf-

ficiency which we cannot explain by the edema or the circulatory disturbances, and also such complications as pericarditis and ulceration of the gastrointestinal tract.

Uremia is a common event, often the terminal one in chronic nephritis, and is less frequent in acute nephritis. The type of chronic nephritis in which uremia is most common is that with little or no edema, with high blood-pressure, lowered phthalein elimination, increased urea and other fractions of the non-protein nitrogen of the blood, and with changes in the myocardium and arterial system. Middle age supplies the majority of such cases. An attack of uremia may terminate a case of polycystic disease of the kidney, or of long standing renal infection. In chronic nephritis with much edema uremia is a rare event.

The onset is often insidious, and especially so in the so-called asthenic type. Commencing with vague indigestion or indefinite psychic disturbances, the condition may progress but little for weeks or even months. Gradually the symptoms may become more severe; vomiting and diarrhea appear, headache and dizziness are added and the patient slowly sinks into stupor and coma, or develops muscular twitchings and later convulsions. On the other hand an individual with almost symptomless chronic nephritis may with alarming suddenness develop convulsions, coma, or perhaps intense dyspnea, and may rapidly go on to death within a few days. Similarly at any stage of the slowly developing attacks rapidly fatal convulsions or coma may supervene. Of the phenomena which occur thus unexpectedly convulsions are by far the most frequent. They resemble epileptic convulsions in many ways, but there is seldom if ever a true aura, or a premonitory cry. Nor does the patient return to clear consciousness as promptly after a uremic convulsion, sometimes continuing in stupor or coma for days. Often the convulsive seizures are repeated at short intervals; they may be associated with a high fever.

Various factors may act as the immediate or exciting cause of a uremic attack. It seldom occurs without an increase of the nitrogenous end products of metabolism in the blood. This constitutes the azotemia of French writers, and uremia is rare with a blood urea nitrogen of less than fifty mgm. per one

hundred c.c. of blood. In passing it might be mentioned
that some foreign writers consider the rest nitrogen of the
blood, that is to say, the non-protein nitrogen exclusive of
the urea, as more significant than the urea in relation to
uremia. Another possible exciting cause, mentioned by nearly
every author, is a sudden decrease in urinary excretion but the
reverse may actually be the case and a uremic attack may ap-
parently be initiated by free diuresis incident perhaps to the
elimination of a dropsy. This perhaps acts by concentrating
the harmful substance in the body. In other instances some
acute infection, trauma, mental shock, or exposure seems to
bear a causal relation, acting perhaps by a harmful lowering
of blood-pressure. There is an optimum level of blood-pres-
sure for the damaged kidney, and this is almost always higher
than the normal in health. Kidney function in a damaged
kidney is more greatly impaired by a fall below than by a
rise above this optimum level. The normal kidney continues
to act despite a marked fall in blood-pressure, perhaps until a
level of about 40 mm. of mercury is reached, but a kidney im-
paired by chronic nephritis and accustomed to an arterial
pressure of 200 mm. or more may fail to act if this pressure
is even moderately reduced. The majority of patients who
have gone into uremia under personal observation, did so
with a blood-pressure which, while perhaps high above the
standard normal, was lower than the patient's previous pres-
sure which was apparently his optimal pressure. When what
appears to be uremia develops at the height of a blood-pressure
increase one should be alert not to overlook an intracranial
hemorrhage. This differential diagnosis has important bear-
ings on treatment.

A few of the many symptoms which may occur with uremia,
have been mentioned. Foster believes they are apt to occur in
groups; convulsions, headache, sudden amaurosis are in one
group, with coma as a sequel. Gastrointestinal disturbances,
definite degeneration of the retina, hallucinations and paranoid
delusions with lethargy and with terminal coma form another
group; gradually deepening coma is the third. In addition
there are a great variety of symptoms which are carelessly
called uremic, and which by the French writers are attributed
to the nitrogen retention, this group includes certain skin man-

ifestations, erythema and itching due perhaps, but very improbably, to the deposit of urea on the skin from the sweat. Visual symptoms are frequent and of varied nature; a true degenerative retinitis, the so-called albuminuric retinitis, may be responsible, or there may be more or less numerous and extensive retinal hemorrhages. The not uncommon uremic amaurosis is as yet unexplained; it may be due to edema of the optic nerve or retina, or to a central cerebral action. Tinnitus is a frequent complaint and partial deafness may occur, perhaps from hemorrhage into the internal ear. The other special senses are not commonly affected except for an unpleasant metallic taste in the mouth; the heavy somewhat urinous odor of the breath is seldom noticed by the patient.

Disturbance of the central nervous system results in most important symptoms including headache, drowsiness, restlessness, insomnia, lethargy, stupor, coma, and psychic troubles varying from mild melancholia or delusions to severe delirium or mania. Local paralysis or even a hemiplegia may be of purely uremic origin and may closely simulate the results of a cerebral hemorrhage or thrombosis, but at autopsy no macroscopic lesion can be discovered In two such cases Weisenburg found degenerative changes in the cells of the motor tract on the one side, but no gross lesions. Finally it is assumed that the convulsive attacks have a cerebral origin.

Important because of early occurrence and frequent prominence are the symptoms referable to the digestive tract; loss of appetite, nausea, vomiting, hiccough and diarrhea. The latter has been explained as an effort at compensatory elimination, for the watery stools contain urea and ammonium carbonate.

Cheyne-Stokes respiration is common in uremia and dyspnea also often occurs. The difficulty in breathing may be due to some centric effect, to pulmonary edema, hydrothorax, or failing circulation, and the paroxysmal dyspnea, the so-called "renal asthma," is probably toxic in origin. There is, however, some little evidence that acidosis plays a part in the dyspneic attacks. Strictly speaking there are no cardiovascular symptoms of uremia although the pulse rate and blood-pressure may vary widely in individual cases. Many of the symptoms which are now explained as due to toxic action

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may eventually find their true explanation in some disturbance of the circulation or vascular system.

Vague nutritional disturbances, loss of weight, weakness or anemia may be for many months the only symptom complained of by a patient with chronic nephritis and approaching uremia. Sometimes the disturbed digestion is responsible; sometimes too limited a dietary has mistakenly been enforced. Perhaps, however, these symptoms belong in the same category of toxic manifestations.

Finally certain secondary pathological processes occur with sufficient frequency in association with uremia to be considered of uremic origin. One group of these manifestations includes ulcerative lesions of the mouth, esophagus, stomach and intestines. Varying grades of stomatitis are common, while the gastric lesions are less frequent and tend to be minor erosions sometimes sufficient, however, to lead to hemorrhage. True ulcers occur in the esophagus and in the lower bowel. Hemorrhagic recto-colitis with indolent ulcers in the colon and rectum may lead to extensive hemorrhages at a stage when the presence of uremia may still be unsuspected. Another group is made up of serous surface involvements of which the most frequent is a dry pericarditis. In chronic nephritis with approaching uremia the discovery of a localized pericardial friction with little or no pain is far from rare; effusion seldom ensues. Occasionally the pleura exhibits a similar process and chronic localized peritonitis especially about the spleen is also often found at autopsy where death has occurred in uremia. There is no satisfactory explanation for these various serous surface involvements and perhaps it may be excusable to call them toxic.

The ulcerations along the digestive tract and the low grade serositis just mentioned, taken together with nephritic changes in the kidneys and some edema of the brain are the only findings which at autopsy suggest that death was associated with uremia.

Circulatory Symptoms. As a result in renal insufficiency, of the associated changes in the arteries, heart and blood-pressure, many symptoms of circulatory nature may arise; and the cardiovascular factor may be primary in the pathogenesis of many of the phenomena now commonly attributed to toxic

action. Thus, for example, a circulatory disturbance may be the mechanism of production of the so-called nephritic headache, and of certain manifestations of edema, especially such local collections as appear in the peritoneal and pleural cavities. The difficulty of deciding the immediate cause of dyspnea in a patient with severe chronic nephritis, mild acidosis and a failing myocardium is obvious.

Increase in blood-pressure to some degree is associated with most instances of definite interference with renal function of more than transitory duration. There is no need of enumerating the various kidney lesions with which this occurs; it develops in cases in which the predominant symptom is dropsy as well as in those with marked nitrogen retention. To an inconstant degree it is seen in acute nephritis, the systolic pressure rising to perhaps 140 or 160 mm. of mercury; but it is with chronic nephritis that high blood-pressure, a systolic reading of 200 to 280 perhaps, and its harmful results are most constantly seen. Sometimes the increase of pressure seems to bear a relation to the retention of salt, at others to the development of uremia; but actually why increased blood-pressure is associated with kidney insufficiency is not known. The tendency is to explain it on an arterial disease which may or may not also be the basis of the renal damage. True it is that renal insufficiency seldom exists long without there occurring an increase of blood-pressure, and high blood-pressure of this type is never long seen without changes in the arteries and hypertrophy of the heart becoming apparent. We are far from sure, however, that the arterial changes may not often or even as a rule precede the increase in the blood-pressure. Kidneys, arteries and heart are so intimately interrelated that it is impossible to think of one without the other two. Apparently at times and especially in acute nephritis, hypertension occurs and with cure of the renal condition disappears, leaving no trace of arterial change; in other instances primary arterial disease eventually involves the kidney as part of a general arteriosclerosis.

Between these two extremes there occur all grades and combinations. For a fuller discussion of this subject the reader is referred to the section on diseases of the arteries (page 607).

Cardiac hypertrophy is so constantly and inevitably as-
sociated with long standing high blood-pressure that in chronic
nephritis with hypertension the degree of enlargement of the
heart can be used as a rough index of the chronicity of the
kidney process. Acute renal insufficiency seldom, if ever,
brings about cardiac hypertrophy, but in the chronic cases an
enormous hypertrophy may develop without any valvular or
pericardial lesion. Ultimately in such cases if uremia or some
unrelated cause does not terminate life, cardiac failure or some
vascular tragedy will. Often the onset of cardiac weakness is
sufficient to precipitate more definite renal insufficiency, and
the final picture is a combination of cardiac and renal inade-
quacy. In such late cases it is often difficult to assign the
primary or even the predominant rôle to either heart or kidney.
The failure of the myocardium may increase dyspnea; alter the
behaviour of the edema, lead to jaundice, cause palpitation,
precordial distress and arrhythmia, and finally by passive con-
gestion increase the kidney difficulties and to some extent
change the urinary picture. This so-called "cardio-renal"
complex is especially prone to develop in middle age when it
is likely that neither heart, arteries nor kidneys are structurally
or functionally up to par, and when failure of one promptly
brings about embarrassment of the others with a toppling
down of the whole triad.

While arterial disease is to be described elsewhere there
are certain arterial phenomena which occur with such peculiar
frequency in nephritis and renal insufficiency as to suggest that
in their origin there is some added factor, perhaps toxic, over
and above any primary arterial disease or heightened pressure.
In these phenomena arterial spasm may be of great frequency
and importance. Dieulafoy has emphasized the significance as
an early symptom of chronic nephritis of the so-called "dead
fingers;" one or more fingers become bloodless, pale and numb;
there is subjective tingling and cramp-like pains, the attacks
come and go, leaving no permanent injury to the part; rarely
the toes, occasionally a whole limb is affected. Arterial spasm
is probably the cause, and the same etiology is responsible in
all likelihood for the cramps in the calves of the legs which
also commonly occur with renal insufficiency. Cramps also
occur in other locations, sometimes in the arms or in the shoul-

der muscles, and Dieulafoy mentions torticollis from the same cause. Such arterial spasms might explain some of the transitory hemiplegias and monoplegias which develop suddenly, pass off in a short time and leave no residual palsy. Possibly uremic amaurosis may have some such vascular disturbance as its cause.

Hemorrhagic phenomena are frequent in chronic nephritis with hypertension, and even more so when there is also some intoxication of uremic nature. By far the most common is epistaxis and this also occurs in individuals with simple arteriosclerosis and hypertension but no special kidney disease. In this latter group the hemorrhages are apparently due to the rupture of small diseased vessels by the hypertension and are analogous to the retinal and cerebral hemorrhages which occur in arteriosclerosis with high blood-pressure. With renal insufficiency, however, an added factor apparently toxic, seems to increase the likelihood of hemorrhages. In the eye retinal hemorrhages are frequent in association with the degenerative changes known as albuminuric retinitis which to the trained examiner at once suggests a severe renal insufficiency. Retinal hemorrhages may, however, occur alone in renal insufficiency without, at least for a time, any of the degenerative changes which go to make up the picture of albuminuric retinitis. It is both difficult and important to differentiate between such retinal hemorrhages of renal insufficiency and those of simple arteriosclerosis; prognostically the latter are much less serious.

The toxic factor already referred to, which in serious renal insufficiency increases the tendence to hemorrhagic phenomena, may perhaps act on the vascular endothelium. Certainly the action is widespread, for in this group occur epistaxis, retinal and cerebral hemorrhages, and also, but more rarely, oozing from the gums, vomiting of blood, passage of blood in the stools or urine, bleeding from the lungs or upper respiratory tract. Menorrhagia and metrorrhagia may occur, although Bartels states that he never observed such a case. At times a general oozing from all mucous membranes, and an appearance of purpuric spots in the skin simulates a terminal stage of aplastic anemia. It is, however, a simple symptomatic purpura and unassociated with any decrease in the

platelet count in the blood as would be present in aplastic
anemia. In one case of terminal renal insufficiency with epis-
taxis, metrorrhagia and oozing from the gums the blood plate-
let count was two hundred and twenty thousand, eight hun-
dred per cubic millimeter. Hemorrhages of this toxic variety
are of very serious prognostic import; seldom do they long
antedate the appearance of uremia. General mucous mem-
brane oozing and purpura only appear when death is to be
looked for within a week or two. In the case just mentioned
death occurred five days after the appearance of mucous mem-
brane bleeding, but epistaxis and menorrhagia had been pres-
ent intermittently for two years.

DIAGNOSIS OF RENAL INSUFFICIENCY.

SYMPTOMATIC.

It frequently happens that a middle aged individual, ap-
prehensive perhaps of the early onset of the degenerative
changes of old age, visits a physician for examination and
prophylactic advice. Usually such an individual admits of no
symptoms and claims to be in perfect health. We know, how-
ever, that our patient is approaching the degenerative period of
life and that it is our duty to recognize as early as possible the
organ which will fail first or most seriously, in order that
measures may be taken to maintain its functional sufficiency
as long as possible.

What, under these conditions should direct our suspicions
to the kidneys; can we recognize the beginnings of renal
insufficiency before symptoms develop and before our tests
of renal function show change? Unfortunately the evi-
dences are few and in the majority of instances our diag-
nosis is made much later than we could wish. We may
occasionally have our suspicions raised by finding in the
patient's story or examination one or more of the factors
which have been detailed under etiology; perhaps it will
be a familial tendency to nephritis, perhaps in early child-
hood there occurred a scarlatinal nephritis, or later in life
a renal insufficiency during pregnancy; perhaps the his-
tory may include some such factor as chronic exposure to
lead, habitual over-eating, longstanding diabetes, or occur-

rence in the past of some apparently cured renal infection. We know that prolonged suppuration may damage the kidney by amyloid change, that renal tuberculosis is frequent in early middle age, especially in women, and that certain types of individuals tend to develop chronic nephritis. The nephritis, however, which such "hard work and no play" individuals acquire is largely a part of a generalized arterial disease rather than a true primary affection of the kidney. It is even conceivable that one might be led to suspect a tendency to renal disease by the discovery of the absence of one testicle or by some other of the abnormalities which are often associated with congenital malformations of the kidneys. Finally, "renal infantilism" might be recognized but in such cases death or at least serious renal insufficiency has, as a rule, occurred before middle age is reached. None of these are very reliable guides and as a rule we must wait upon the appearance of symptoms, physical signs, or change from normal in functional tests. The factors mentioned above, however, should make us alert to recognize and properly interpret at the first possible moment, the early evidences of the kidney failure.

The onset of renal insufficiency may be insidious or abrupt, depending upon the nature of the kidney trouble. In acute nephritis and acute infections of the kidney an abrupt onset of renal insufficiency is frequent, and even in such long-standing conditions as polycystic kidneys or chronic nephritis the appearance of renal insufficiency may be sudden, usually as a result of a superadded acute process or passive congestion. As a rule in chronic nephritis, however, the onset of symptoms is very insidious; for years there may be only such symptoms as headache, polyuria, nocturia, indefinite disturbances of indigestion, loss of strength and ambition, slight puffiness of the eyelids and ankles. These phenomena are often misinterpreted or overlooked. One patient complained that his sensation of "awful exhaustion" had never been received seriously by the many physicians he consulted. Sometimes the symptoms become gradually worse; in other instances they seem to remain stationary for long periods until some intercurrent infection or other factor brings about a sudden increase in the renal failure. From the point of view of early diagnosis it matters little whether a symptom is the result

directly of a renal insufficiency or of an associated arterial disease or hypertension. It is of the utmost importance, however, to appreciate properly the possible significance in diagnosis of this group of seemingly trivial symptoms.

In the very early stages there is little or nothing characteristic in the appearance of the individual. The classical descriptions of patients with nephritis are of those in a moderately advanced stage, or else the appearances described are those of the associated arterial disease as, for example, the tortuosity of the temporal vessels. A certain pallor of the face is often emphasized as an early sign of nephritis, and a moist, glistening sclera is said to precede edema, sometimes by a considerable period.

An insidiously developing increase of blood-pressure is the rule, and may precede all other symptoms or signs of oncoming renal insufficiency. One must always exclude primary arteriosclerosis, the climacteric, etc., but in a middle-aged individual, especially in the earlier years of middle age, continued hypertension should be considered a symptom of renal disease unless there is good evidence to the contrary. The increase of pressure need not be very great although more significance is attached to higher pressures. In acute nephritis the other evidences of renal insufficiency are usually so evident that the moderate increase of blood-pressure is seldom of much diagnostic assistance; if the pressure is more than moderately raised it suggests some previously unrecognized chronic renal damage. In chronic nephritis the hypertension may be of great diagnostic help even very early in the case, but it must be remembered that in the type of chronic nephritis with edema the blood-pressure even in the later stages is often not higher than 160 mm. Hg. Hypertension associated with renal insufficiency may also occur in hypertrophy of the prostate and other obstructive lesions of the lower urinary tract, and also in certain cases of renal calculus and renal infections.

When renal insufficiency develops abruptly its symptomatic diagnosis is apt not to be very difficult. Sometimes its first manifestations may take the form of uremic convulsions, extensive dropsy or an albuminuric retinitis, but it is likely that in many such instances there have for some time existed prodromal symptoms, the significance of which was missed.

ROUTINE URINE ANALYSIS.

Little needs to be added to what was said in the previous chapter concerning the findings in the urine in disease of the kidney. The early diagnosis of unsuspected renal trouble has been greatly assisted by the increasing frequency of routine urinary examinations and the further investigation of any abnormal finding such as albumin, casts, blood, or pus. Any of these may be indicative of serious renal damage and may occur as the only recognizable evidence of the trouble. They do not help in the diagnosis of renal insufficiency directly, but by directing attention to the kidneys they result in proper study of the kidney lesions and an estimate of any impairment of renal function which may be present. In this latter the tests of function which will next be described, are employed.

DIAGNOSIS BY TESTS OF FUNCTION.

Undoubtedly tests of renal function are of great value and give helpful information from several points of view concerning the functional adequacy of the kidneys. But much has been written which implies a far greater certainty of correlation between the results of such tests on the one hand, and the clinical picture and autopsy findings on the other. Superficially much may seem to be in accord, but actually there are wide discrepancies. Attempts have been made to associate certain tests with certain parts of the kidney unit but with only poor success; and as long as there is any doubt concerning the function of the individual parts of the kidney unit of excretion, and as long as it is uncertain whether a given test is measuring the function of any single part or of the whole, it will continue to be impossible to foretell by functional tests the exact pathological changes which will be found in the kidney. Nor do we wholly understand all of the many variables which enter into some of even the apparently simplest tests. Many extrarenal factors, for example the normality of the circulation, the recent diet, fever, "acidosis," and even psychic disturbances may tend to disturb the results of the tests. Proper control of these many sources of error is necessary, and the greatest help can only be obtained from a method whose limitations we know and allow for.

One error which has long been persisted in, is the attempt
to draw conclusions concerning the sufficiency of renal func-
tion from the determination of the amount and concentration
of nitrogen or urea in a single specimen of urine without pro-
per control of the diet and of the many other factors which
may markedly alter the findings. Carried out in complete de-
tail such a metabolic study may be of great value but demands
more control of the patient and more facilities than can usu-
ally be had outside a hospital. Certain simple modifications
have been described which as well as other tests of kidney
function can be carried out under almost any circumstances.

**Tests of Function Based on the Renal Response to
Physiological Test Substances.** One of the simplest methods
of studying kidney function is by the determination of the
organ's response to the ingestion of arbitrarily fixed amounts
of one or more of the substances which the kidney habitually
excretes. Water, sodium chloride and urea are the substances
usually chosen for use in this test. The normal kidney under
normal conditions excretes during a twenty-four hour period
specimens of urine which vary widely in specific gravity, and
in their content and concentration of solids such as salt and
urea. These normal changes are the result of a number of
factors, and the degree of variation can usually be increased
by intentional changes in the diet and fluid intake. In other
words the normal kidney responds to the changing conditions
incident to meals, exercise, sleep, etc., by excreting at one
time a dilute urine with a low specific gravity and at another
a concentrated urine of high specific gravity. A variation
of at least 0.009 in the specific gravity of the different speci-
mens passed in the twenty-four hours is almost always seen
in the normal. This ability of the kidney to respond to vary-
ing conditions with the excretion of a urine of varying con-
centration is a function of fundamental importance and one
which is very early interfered with in certain forms of renal
disease. For these reasons tests of this function are of great
importance.

According to the method of performance, tests of this func-
tion have received a variety of names. Dilution and concen-
tration test, fixation of specific gravity test, water test, and in
combination with studies under controlled conditions, of the

excretion of salt and urea it has been named the renal test meal, the two hour test, or the test of Volhard or of Mosenthal.

In its simplest form one merely determines the specific gravity of individual specimens of urine passed under varying conditions of fluid intake. Under average conditions the normal kidney will pass urine varying in concentration from perhaps 1.008 to 1.020, while after a limitation of fluid intake for perhaps 10 hours the concentration will rise to 1.026, only to drop rapidly to 1.006 or even lower after the free administration of water.

The failure of the kidney to produce concentrated urine when the available fluids of the body are diminished is evidence that the kidney function is not normal. The more narrow the limits within which the specific gravity varies the more severe is the renal insufficiency; in the worst cases the specific gravity is fixed usually between 1.011 and 1.013. In such cases there may be also a lag in the excretion of water when given in more than small quantities. Before drawing conclusions from a fixed low specific gravity and an apparent inability of the kidney to concentrate one must be sure that the amount of fluid being ingested is not sufficient to account for these findings by simple dilution, and secondly that this result is not being brought about by the elimination of a dropsy. Also one should note that the fixation of specific gravity must be at a low figure in order to be significant of disturbed renal function; fixation at a high level 1.030 perhaps may be due to low fluid intake, to the coincident development of a dropsy, to chronic passive congestion of the kidneys, and it is a common occurrence in fever and in acute nephritis. With these exceptions this simple test is applicable to all cases and may give early information of a developing renal insufficiency. It is not known in what part or parts of the renal excretory unit the power to concentrate resides, and so interference with this function does not point clearly to any particular anatomic defect or pathological change. It is, however, in chronic nephritis without edema that this test most constantly gives evidence of the renal insufficiency. The following table shows the type of results which are to be expected with this test when applied to kidneys with normal function and with impaired function.

NORMAL FUNCTION

Specimen obtained at about	Uncontrolled day		Dry day No water since 10 p.m. previous evening and minimum amount with meals		Diet as usual plus 1000 c.c. fluid given at 6 a.m.	
	c. c.	Sp. gr.	c. c.	Sp. gr.	c. c.	Sp. gr.
7 a. m.	200	1.010	150	1.014	260	1.008
10 a. m.	230	1.018	160	1.020	370	1.002
1 p. m.	190	1.014	100	1.027	290	1.008
4 p. m.	270	1.026	80	1.035	210	1.014
7 p. m.	210	1.008	60	1.030	200	1.018

RENAL INSUFFICIENCY

Specimen obtained at about	Uncontrolled day		Dry day No water since 10 p.m. previous evening and minimum amount with meals		Diet as usual plus 1000 c.c. fluid given at 6 a.m.	
	c. c.	Sp. gr.	c. c.	Sp. gr.	c. c.	Sp. gr.
7 a. m.	200	1.011	160	1.013	190	1.012
10 a. m.	180	1.013	150	1.013	200	1.012
1 p. m.	220	1.010	130	1.012	230	1.009
4 p. m.	190	1.012	160	1.011	220	1.010
7 p. m.	180	.1.010	180	1.010	200	1.013

By some the night urine as a single specimen is also saved, and attempts made to draw conclusions as to renal function from the total amount of the specimen and from its content and concentration of sodium chloride and urea. Although theoretically valuable it is probable that far too much reliance has been placed on the conclusions thus arrived at.

Tests with sodium chloride or urea may be carried out at the same time as those with water just described, or they may be performed separately. Before administering the test substance the diet must be controlled for several days until the output of the substance to be employed becomes approximately level. Then to the standard diet is added a single dose, usually 10 grams of the sodium chloride or urea. The normal kidney

should rid the body of this added amount of either of these substances, largely within twenty-four hours and almost completely within forty-eight hours. Any lag in the elimination is supposed to be indicative of impaired renal function, but it is obvious that many extra renal factors must be controlled before conclusions can safely be drawn. For example, failure or delay of absorption of the test substance from the intestinal tract would cause a lag in excretion, and Vallery-Radot has claimed that a physiological retention of part of a single dose of sodium chloride may occur and persist for several days if the individual happens to be in a so-called salt low phase. He believes there is a rhythm of retention and excretion of salt which occurs normally but is accentuated with disturbances of renal function as in chronic nephritis. Apparently one must be cautious not to place too much reliance on the results following a single superposed dose of sodium chloride. Perhaps the same caution should be given concerning urea as well.

There is theoretically much in favor of these tests for the substances employed are those habitually excreted by the kidneys, and by placing a physiological function under temporary strain a latent deficiency of function might be expected to appear which might not be revealed in any other way. Furthermore, it would seem that the larger the dose of the test substance given the greater the likelihood that any inadequacy of function would become apparent, and some workers have therefore used large amounts of the test substances, for example 20 grams of salt, or 30 grams of urea. This latter is equivalent to about 13 grams of nitrogen and it is probable that such large doses can be used with safety only in carefully selected cases, although it is possibly true that by such large doses earlier evidence of renal insufficiency may be obtained.

Many efforts have been made to make use of other aspects of the kidney's response to urea, sodium chloride and other substances in the same group, for the purpose of estimating the sufficiency or insufficiency of renal function. Not only the promptness with which the kidney rids the body of the dose of test substance has been employed as a criterion of function but also the height to which the kidney can raise the

concentration of each substance in the urine; this is analogous to the test of the kidney's ability to concentrate urine when the fluid intake is lessened. For example, MacLean gives 15 grams of urea in 100 c.c. of water, obtains urine at the end of one hour and of two hours, and from the concentration of the urea in the urine of the second period draws conclusions as to the state of renal function.

No opinion can yet be ventured concerning the value of the hippuric acid test; apparently the percentage elimination of hippuric acid after the administration of a known amount of sodium benzoate varies as does the elimination of 'phthalein.

Studies of the relation between the excretion of various substances in the urine and their level in the blood have also been made. The chief interest has centered on urea, and many have been the attempts to express in a single formula the relationship between its blood concentration and the rate of its excretion in the urine. Ambard in 1910 announced the so-called Ambard coefficient based on the belief that, other factors being equal, the excretion rate of urea increases in the normal, as the square of the concentration of the urea in the blood. This was found not to be applicable under all conditions and various modifications have been tried, a most important one by Austin, Stillman and Van Slyke being the introduction into the formula of the factor of the rate of volume output of urine. By the variation beyond normal limits of the index derived from this formula it is now possible to recognize disturbances of the kidneys' urea excreting function but it is not yet possible to adapt the method to the study of renal insufficiency in practice. That this same factor of rate of volume flow may enter into other tests of renal function has lately been suggested in connection with the 'phthalein test.

Deviations from the normal in the results of these tests if properly performed and controlled, are assumed to be indicative of some disturbance of renal function, but it is difficult to go much further. The significance differs with each test substance and in the case of sodium chloride it is far from certain that at times a delayed excretion is not to be explained on wholly extrarenal factors such as a retention in the tissues. It is in the early stages of renal insufficiency, for example in early chronic nephritis, that this group of tests is most val-

uable; they may reveal a deficiency of functional capacity before other evidence is obtainable. In more severe stages they are of less value as one cannot very often estimate the degree of insufficiency with them, nor recognize the location of the kidney damage in respect to the renal excretory unit; one cannot on the basis of the results of these tests distinguish between a nephritis predominantly tubular and one predominantly glomerular. Nor is there any good reason for hoping to be able to do this, for example, there is evidence that urea passes through the glomerular filter and is also secreted by the cells of the proximal convoluted tubules, and that its concentration in the urine is raised by the absorption of water by the lower parts of the uriniferous tubules. If this is true it is evident that in the excretion of urea and probably of all similar substances, more than a single part of the renal excretory unit is involved, and that insufficiency of the urea-excreting function of the kidney does not permit us to localize the trouble in any one part of the kidney.

Therapeutically, however, these tests suggest indications for treatment. As a general principle it would seem that it should be beneficial to limit the ingestion of a substance or of the foods from which it is formed when tests have shown that the kidneys' ability to excrete that substance is below normal. This gives a rational basis for the dietetic treatment of renal insufficiency especially in the early stages.

Tests Based on the Renal Response to Foreign Test Substances. In this group belong the earliest attempts at testing renal function. It was observed in 1830 that in gouty individuals the ingestion of turpentine failed to produce in the urine the characteristic odor, and seven years later the same observation was made concerning asparagus. The next observation was that individuals with damaged kidneys often prove intolerant of various drugs, probably due to the failure of the diseased kidneys to eliminate the drugs with normal promptness from the body. These observations suggested as a test of renal function, the use of some non-toxic substance, foreign to the usual chemistry of the body, whose elimination was in the urine where it could be measured. A great variety of test substances have been tried: Methylene blue, indigo, carmine, potassium iodid, and phenolsulphonephthalein for example,

with each of which the evidence of kidney insufficiency is
measured by the promptness and completeness of elimination
of the test substance in the urine. In medical work today the
most popular test substance is *phenolsulphonephthalein,* a dye
stuff which meets all of the requirements mentioned above.
As the best representative of this group it will be chosen for
further discussion.

'Phthalein, as it is commonly abbreviated, is non-toxic, can
be injected into the muscle or directly into the circulation; it
is eliminated only by the kidneys and is non-irritating to
them ; in the urine it can be readily measured colorimetrically.
As a rule 0.006 grams is the amount injected and normally 60
to 80 per cent. of this amount appears in the urine within two
hours. A lessening of this amount is abnormal, and if other
factors can be ruled out, is strong evidence of renal insuf-
ficiency. It is not, however, a test for the recognition of any
particular disease of the kidneys, nor are we able to say that
it is a test especially of glomerular or of tubular function. It
must be used simply as a test of renal function and as a help in
the diagnosis of renal insufficiency.

Even in this capacity it is not an extremely delicate test.
It is, however, quite constantly decreased in kidney insuffici-
ency with retention of urea, and especially so when uremia is
likely. Chronic nephritis may be present with little or no de-
crease in the elimination of 'phthalein, but as a rule the test
gives correct information as to the degree of the renal insuf-
ficiency present in chronic nephritis, especially in the cases
without edema. However, it is often impossible to correlate
the 'phthalein elimination and the degree of urea retention in
the blood. One must, however, remember that the 'phthalein
test expresses the renal function at the time it is performed
while the urea retention may be the result of weeks of renal
inadequacy.

In acute nephritis the test gives very unexpected results
often not in accord with the clinical picture. In some cases
there is even an abnormally good elimination of the dye.
Amyloid disease of the kidneys interferes with this test very
little, while on the other hand obstructive lesions of the lower
urinary passages as, for example, prostatic hypertrophy with

back pressure on the kidneys, may markedly reduce the elim-
ination of 'phthalein.

A number of extrarenal factors may influence the results of
this test and unless properly controlled may lead to mistaken
conclusions. Failing circulation with passive congestion of the
kidneys may lower the two hour output of 'phthalein to such a
degree as to simulate serious renal insufficiency; and failing
circulation may also alter the result of the test by delaying
the absorption of the dye from the tissues if the injection is
not made intravenously. For this reason 'phthalein should
always be administered intravenously if circulatory failure or
edema is present. Furthermore, there is evidence that under
certain conditions the dye may be fixed or altered in the tissues
in such a way as to interfere with its elimination by the kidneys
or its recognition in the urine. Braasch and Kendall claim
that in acidosis 'phthalein is retained in the tissues and that the
dye will be liberated if sufficient alkali is supplied. In the
urine the colorimetric reading may be interfered with by
the presence of bile or blood, but this difficulty may be avoided
by precipitating down the bile or blood by an equal amount of
saturated alcoholic zinc acetate.

Reduction of the two hour 'phthalein elimination below 40 per
cent. if the test has been properly performed and controlled,
is to be considered indicative of definite renal insufficiency,
but the significance increases as the figure becomes lower.
A figure of less than 10 per cent. is of very grave prognostic
import, but even a zero elimination is compatible with life for
weeks or even months. By repeating the test at intervals the
progress of a case can be followed with considerable accuracy
and more assistance can be had from such comparisons than
from a single test. It is the author's personal view that in the
estimation of renal insufficiency incident to chronic nephritis
without edema, the 'phthalein test is of much less value than
the study of the renal response to water.

Much of what has been said concerning the 'phthalein test is
also applicable to the use of other foreign test substances.
Some of these other substances are perhaps to be preferred for
special purposes, for example, during a cystoscopic examina-
tion, but for medical practice no substance has yet been offered
which excels phenolsulphonephthalein.

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Tests of function Based on Changes of Renal Origin in Composition of Blood. It is the function of the kidney to regulate the composition of the blood and indirectly of the whole body. In health the function of the kidney proceeds with the utmost delicacy; the water content of the body is regulated, the content in the blood of a great number of substances is controlled, and the kidneys help, just as do the lungs, to stabilize the reaction of the blood. Interference with any one of these parts of the kidney function will be reflected in changes in the composition of the blood and can be recognized there as evidence of the renal insufficiency. Only a few of the numerous changes, however, are commonly employed for this purpose, and many which are less specific, for example, changes in the freezing point of the blood, have been discarded. Interest centers to-day especially on the various fractions of the non-protein nitrogen and on the sodium chloride; and to a less extent, at least from the point of view of the measurement of renal insufficiency, on the lipoids of the blood and on alterations in the acid-base equilibrium.

Accumulation in the Blood of Nitrogenous Metabolites (Azotemia). The non-protein nitrogen and its various fractions have in normal blood the following range according to Hammett:

	Milligrams per 100 c.c. blood
Non-protein nitrogen from	27.3 to 45.5
Urea nitrogen from	9.7 to 25.1
Rest nitrogen from	3.7 to 18.3
Amino acid nitrogen from	3.1 to 7.2
Creatin nitrogen from	0.62 to 1.78
Uric acid nitrogen from	0.50 to 1.16
Creatinin nitrogen from	0.37 to 0.60

Formerly the non-protein nitrogen was selected in estimating renal insufficiency, but improved and simpler methods for the quantitative determination of urea nitrogen in the blood have made this latter the favorite today. In the absence of disturbing factors such as excessive protein diet, rapid emaciation, intestinal obstruction, malarial paroxysms, or agonal conditions, a high level of blood urea nitrogen indicates definite impairment of the ability of the kidney to excrete the nitrogenous end products of metabolism.

A moderate increase in the blood urea nitrogen is often seen in acute nephritis especially in the cases with marked oliguria or anuria, but the elevation is much more marked in chronic nephritis, particularly in severe cases with little or no edema. Some increase is usually associated with obstructive lesions of the lower urinary passages; and suppression of urine from any cause always results in a marked raising of the figure. For example, very high figures occur in acute bichloride poisoning. Uremia rarely develops in the absence of a high blood urea nitrogen, and this is also true of the majority of toxic symptoms which are so often the precursors of uremia.

Over 20 mgms. of blood urea nitrogen is suggestive, and over 30 is definitely indicative of renal insufficiency if all other factors can be excluded. As the blood urea nitrogen increases it usually forms a greater and greater percentage of the total non-protein nitrogen; at the normal level it constitutes but a half, while when it has reached a high figure such as 200 or 250 mgms. it usually makes up over 80 per cent. of the total. Some laboratories report the urea rather than the urea nitrogen figure and as the nitrogen is roughly but one-half of the urea it is important not to confuse the two.

Some of the extrarenal factors which may increase the urea nitrogen content of the blood have been mentioned, but special reference should be made to the increase which may follow the rapid disappearance of dropsy. There is fairly good evidence that the blood and tissues have approximately the same content of urea, and that with a more rapid excretion of water than of urea an actual concentration of urea in the body may occur. This would apply, of course, not only to urea but to all substances whose excretion was interfered with, and so might be the explanation of those instances of uremia which develop immediately following the elimination of an edema, either spontaneously or as a result of eliminative measures.

A low blood urea nitrogen is found in the later months of normal pregnancy, and although the total non-protein nitrogen is also low the urea nitrogen forms less than half. It may be found as low as 4 mgm. per 100 c.c. of blood, and 8 or 9 mgms. is not unusual. Only with rapidly growing carcinoma have similar figures been found. When renal insufficiency develops late in pregnancy the blood urea nitrogen rises as it does under

other conditions. In certain of the toxemias of pregnancy, however, and especially in those probably of hepatic rather than renal origin, there occurs a sharp rise of the non-protein nitrogen with little or no corresponding rise of the urea nitrogen. This latter may finally constitute but 15 per cent. instead of the normal 50 or more per cent. of the total non-protein nitrogen of the blood. It is obvious that in such cases an estimation of both the non-protein and urea nitrogen should be made.

In the diagnosis of renal insufficiency great assistance can be had from the estimation of the blood urea nitrogen. This is true not only in those instances in which the figures obtained are above normal and so, if other factors can be controlled, are guides to the degree and progress of the impairment of renal function, but also low and normal figures may be of help in differential diagnosis by the probable exclusion of renal insufficiency. For example, extensive arterial disease with hypertension may occur in middle age with little or no renal impairment, yet following an arterial tragedy such a patient may closely simulate the picture of uremia. An arteriosclerotic patient of mine suddenly developed such a condition as a result of an apoplexy. The diagnosis was rendered easier by the finding of but 9 mgm. of blood urea nitrogen. This was good evidence that, as was later confirmed, the trouble was of circulatory rather than uremic nature.

Another aspect of this subject is worth illustrating by the following case. A woman, aged 41, was found semiconscious in her room. No history was obtainable. There were no localizing signs of a cerebral hemorrhage but there was blood in the spinal fluid on several removals. The blood-pressure on admission was systolic 175, diastolic 110, and there were many retinal hemorrhages. The blood urea nitrogen was 48 mgms. per 100 c.c. and the 'phthalein test extremely low; the urine suggestive of chronic nephritis. A progressive fall in the blood-pressure, and rise in the blood urea nitrogen occurred until on the day of her death, the tenth day after admission, the systolic blood-pressure was only 110 mm. Hg and the blood urea nitrogen had reached the very high figure of 250 mgms. At autopsy a hemorrhage was found in the left Sylvian fissure; the kidneys were very small, red and granular,

with much fibrosis and great retraction of the cortex. In this case the diagnosis of the cerebral hemorrhage was not so difficult at first, but later as the evidence of renal insufficiency became more and more marked, perhaps as a result of the lowering of blood-pressure, the confusion with uremia became increasingly certain. Seen for the first time shortly before death one would in all probability have diagnosed uremia and failed to suspect the underlying cerebral hemorrhage.

Uric acid and *creatinin* in the blood are also estimated at times in the hope of gaining further information than that supplied by the blood urea nitrogen figure. It is claimed that uric acid nitrogen increases earlier in renal insufficiency than does urea nitrogen, while on the other hand creatinin does not show much increase until a fatal outcome is imminent. Theoretically it is more difficult for the kidney to excrete uric acid than urea or creatinin, for the kidney normally can concentrate creatinin 100 times, urea 80 times, but uric acid only 20 times. For this reason it is claimed that uric acid is the first substance to have its excretion interfered with in renal insufficiency. The evidence on this point, however, is still somewhat confusing. In gout there often occurs a high uric acid content in the blood without increase in the other fractions of the non-protein nitrogen, and if gout is a manifestation of renal insufficiency as has been frequently suggested, it must be the result of an insufficiency of a single, very specialized function of the kidney for the excretion of uric acid. While possible this scarcely appears probable.

Creatinin is entirely of endogenous origin and so is uninfluenced by many factors which affect the blood urea nitrogen; it is usually measured as creatinin rather than as creatinin nitrogen. The creatinin in the blood remains remarkably constant until serious insufficiency of kidney function is present; an increase to over 5 mgm. per 100 c.c. is claimed to be a very serious prognostic omen. Little use is made of the other fractions of the non-protein nitrogen of the blood in the diagnosis of renal insufficiency, although there is some evidence that the rest-nitrogen is more increased in uremia than in the urea nitrogen. For practical purposes the urea nitrogen estimation is preferred both because of the wide range of increase, and convenience of method.

Sodium chlorid may be estimated either in the whole blood or in the plasma, and an increase above the normal is suggestive of a retention of this salt. High figures are frequent in renal insufficiency with dropsy as, for example, in acute nephritis and in certain cases of chronic nephritis, but there is no great constancy even in the same patient. An increase in the sodium chlorid of the blood may also occur without dropsy, and this may be of help in treatment, as will be mentioned later. On the whole the diagnosis of renal insufficiency is not greatly assisted by studies of the sodium chlorid of the blood, although in many instances this substance is increased much above normal.

Studies of the *blood lipoids* have not advanced far enough to be of much practical value in the diagnosis of renal insufficiency. *Cholesterin* is often increased in the blood in conditions of failure of kidney function, especially in chronic nephritis, but it has not been demonstrated that this is peculiar to renal disease and no conclusions can as yet be drawn. Chauffard attributes certain of the phenomena of chronic nephritis to the increased blood cholesterin, and the so-called snowball opacities in the vitreous in chronic nephritis have been blamed on the same cause. On the same grounds attempts have been made to base prognosis in chronic nephritis, but cholesterin is found increased in so many other conditions, for example some instances of nephrolithiasis, as to make all conclusions doubtful.

The maintenance of the *acid-base equilibrium* of the body is in part a function of the kidney, and as might be expected renal insufficiency may lead to disturbances of this important balance. The resulting "acidosis" is chiefly due to the failure of the kidney to continue its function of excreting the acid substances normally produced in the body. The acidity of normal urine is the result of this renal function and is evidence of the kidneys' ability to remove relatively a larger amount of acid than of alkaline phosphate. Retention of inorganic phosphates has been demonstrated in renal insufficiency. The degree of diminution of the alkaline reserve which may occur with renal insufficiency is considerable and may be recognized by the usual methods, but neither its presence nor its severity are very much help in the diagnosis of renal insufficiency or of

the underlying kidney disease. Further investigations may prove, however, that diagnostic, prognostic, or therapeutic help may be gained from the recognition of this disturbance, or from the demonstration in the blood of a retention of phosphates or other acid substance.

By the use of the various tests just mentioned, the diagnosis of renal insufficiency, can be established, and a good estimate of its severity obtained. Often by a combination of several tests some insight can be had into the nature of the kidney disease which is at the bottom of the renal insufficiency. Furthermore by the repetition of tests an idea of the progress of a case can be gained, and suggestions for treatment are supplied by the knowledge of which functions are impaired. The results to be expected from the various tests in the different diseases of the kidney will be given later when each disease is discussed. Special mention, however, should be made at this point of the use of these tests in the recognition of renal insufficiency under certain special conditions.

Tests of Renal Function in the Routine Examination of the Middle Aged. In the routine examination of an individual who presents nothing suggesting disease of the kidney, either in the symptoms complained of, the urine analysis, or on physical examination, the performance of tests of renal function is uncalled for. But in all such examinations and especially in persons of middle age or over, one should be sure that none of the items discussed at the beginning of this chapter are overlooked and, secondly that the urine is carefully and intelligently examined. Special attention should be paid to any tendency of the specific gravity to be fixed at a low level for this may give the only suggestion of renal insufficiency. Any hint of possible kidney disease should lead at once to a study of the renal function. The response of the kidney to variations in water intake, and the 'phthalein test had best be determined first; and further tests carried out only if indicated. It is not unusual for the 'phthalein test to reveal a startling and unexpected degree of renal insufficiency; much less often will a determination of the blood urea nitrogen give us the evidence of an unsuspected renal inadequacy.

Estimation of Renal Function Preparatory to Surgical Operation. Many factors enter into the problem of whether

a middle-aged patient has sufficient kidney function to with-
stand the strain of an operation. Among these factors are the
nature, extent and urgency of the surgical procedure, the an-
esthetic, the general condition of the patient, and the in-
tegrity of the cardiovascular system. As a result of the num-
ber of variables it is impossible to lay down any but general
principles.

If the operation is not to involve the kidney and urinary
passages, the chief factors to be considered are the toxic action
of the anesthetic, the possible effect on blood-pressure, and any
unavoidable postoperative restriction of fluid. Both ether and
chloroform are irritant to the kidney, and, if renal insuffici-
ency is present, should be avoided and local or nitrous oxide-
oxygen anesthesia substituted. Antiseptics which are also
renal irritants such as phenol should not be freely employed.
Every effort should be made to maintain the blood-pressure at
its usual level even if this has been above the normal. A
lowering of blood-pressure which comes from preoperative
rest is, of course, desirable, but the lowering which results
from operative shock often seriously interferes with kidney
function and may indeed be one of the factors in postoperative
anuria. Most important is a daily adequate supply of fluid
which need not be given by mouth, but will serve as well if
administered by other routes. If these factors are kept in
mind and every effort made to meet them there is no serious
contraindication to operation on patients with moderate renal
insufficiency. If the operation is not urgent a preoperative
period of medical care, with rest, dieting and increased elim-
ination will often improve matters considerably. Of course,
the more serious the renal insufficiency the greater the desira-
bility of avoiding any surgical procedure. and the more im-
portant it is to take steps to aid the impaired kidneys. Fin-
ally in a patient approaching uremia, or with extreme anasarca,
the contraindication is almost prohibitive except for an opera-
tion of vital urgency, or one directed at the relief of the renal
insufficiency itself.

Operation on a kidney should never be performed, except in
the most extreme emergency, without a preliminary deter-
mination of the presence of its fellow and the functional ac-
tivity of each. Any kidney operation may end in nephrectomy,

or may be followed by complete failure of functional activity of the insulted organ for a period long enough to lead to great danger if the opposite kidney is unable to bear the double load.

The finding of two ureteral openings into the bladder is not sure proof of the presence of two separate kidneys; both ureters may lead to a single kidney, or as was the finding in a recent case of renal calculus, to a horseshoe kidney. Information must be obtained as to the functional sufficiency of both kidneys; of the one to be operated upon in order to gauge its possible value to the body, and of the other in order to decide whether it might safely be counted upon to assume the duties of both. Confusion arises when impairment of the functional capacity of the supposedly healthy kidney is found; it may be simply reflex to the disease of the other kidney, and in this case removal of the diseased organ will usually improve conditions; on the other hand it may be due to actual disease, in which case removal of even a feebly acting organ may place an unbearable strain on the remaining kidney with disastrous results. As a rule the removal of a functionless or almost functionless kidney more often raises than lowers the functional adequacy of the opposite kidney. A 'phthalein test of 30 per cent. will often rise to 50 per cent. after the removal of renal calculi, for example, but if the 'phthalein be lower than 20 per cent. and the blood urea nitrogen much above normal operation on the kidney should be, as a rule, deferred.

Operations on the bladder, prostate or lower urinary passages, especially if obstruction with back pressure on the kidneys has existed for any time, should always be preceded by a study of the functional activity of the kidneys. The importance of this measure is well evidenced by the marked improvement in impaired renal function which can usually be obtained before operation in cases of hypertrophy of the prostate with obstruction, with consequently a marked lessening in mortality. Catheter drainage of the bladder, rest, dieting and increased elimination are the measures which will lessen the renal insufficiency, and the internist in such cases should withhold his opinion as to the advisability of operation until the full effects have been obtained. In these cases of obstruction the blood urea nitrogen gives probably the most de-

pendable information concerning any renal insufficiency which
may exist; the 'phthalein test is also helpful.

Tests of Renal Function in Relation to Pregnancy. Preg-
nancy in an individual with even moderate renal insuffici-
ency is a serious matter, and the physician is often asked
whether in a given instance pregnancy should be allowed to
proceed to term. In arriving at a decision may factors must
be considered of which the degree of renal inadequacy is per-
haps the most important, and in the measurement of this the
tests of renal function will prove of more assistance than the
history, symptoms or physical findings.

In severe renal insufficiency pregnancy should be warned
against and terminated if it occurs, for the danger to the
mother is great and the likelihood of a living child at term is
small. In addition the pregnancy tends to aggravate the kid-
ney trouble. On the other hand if the results of the tests in-
dicate a very mild renal insufficiency it is justifiable to permit
the pregnancy to proceed with the patient under careful obser-
vation. The functional capacity of the kidneys should be
tested at intervals and the pregnancy terminated if a steady
increase of renal insufficiency occurs. When chronic nephritis
is the cause of the renal insufficiency the increasing evidence
of kidney failure usually makes its appearance in the early
months of pregnancy, and as a rule both the 'phthalein test
and blood urea nitrogen estimations will show marked ab-
normalities. If serious insufficiency is demonstrated early in
pregnancy before the child is viable it is the part of wisdom
to terminate the pregnancy, but the nearer the period of via-
bility approaches the more justifiable it is to tide things along
in the hope of saving the child. After the seventh month one
should always temporize unless more alarming symptoms,
such as an albuminuric retinitis appears or the functional
tests show a steady decrease in renal sufficiency despite care-
ful treatment. So many variables enter this problem that it is
impossible to state the figures for the different tests which
would lead one to terminate pregnancy or the reverse. Each
case has to be decided for itself. It must be remembered that
eclampsia and its premonitory manifestations are not primarily
of renal origin and that tests of renal function may give no
warning of the approach of these complications of pregnancy.

TREATMENT OF RENAL INSUFFICIENCY AND ASSOCIATED CONDITIONS.

In the treatment of renal insufficiency one may attempt to remove the cause, correct perversions of physiology and relieve individual symptoms. The effort to restore functional compensation of the organ may be approached from three aspects; one may lessen the demands made on the impaired renal function, protect it from overstrain and by so doing decrease any harmful results which may have occurred; secondly, one may increase compensatory elimination by other routes, and finally one may cautiously stimulate the failing renal function. It would be desirable always to know the nature of the kidney disease which has brought about the renal insufficiency, dropsy or uremia, but often these will require treatment, more or less irrespective of the exact causative disease. It must never be lost sight of, however, that such treatment can not be highly satisfactory and that many features of the treatment must depend upon the disease picture as a whole and the patient as an individual.

TREATMENT OF ANURIA.

So alarming is complete suppression of urine that one restrains with difficulty a tendency to overactive treatment. The harmful results of short periods of anuria are often amazingly few, and little treatment is required. For example, after any surgical operation anuria or extreme oliguria may occur, persist for a day or two, and be followed by a return of normal excretion without any special treatment. In such cases if the blood-pressure is much lowered, as in shock, the treatment of the urinary suppression becomes of secondary moment to that of the circulation. Sometimes anuria follows promptly on the action of some irritant substance, such as a single application of cantharides, and in such instances the removal of the offending substance will often be sufficient. If, however, the poison is more violent or has acted over a longer period active treatment of the renal failure is indicated. Some severe cases of poisoning as, for example, with corrosive sublimate, and some cases of suppression from calculus may defy all treatment. Such forms of anuria as those seen in hysteria or after catheteriza-

tion or marked renal trauma as a rule require no treatment
of this feature. Urinary suppression is not rare in the more
acute forms of nephritis, probably as a result of acute degen-
erative changes in the renal parenchyma, and hyperemia and
edema of the kidneys.

When anuria is associated with actual renal damage or dis-
ease there is little that can be done to improve matters
directly in the kidney, and diuretics of all kinds are strongly
contraindicated. Even water in more than moderate amount
is probably harmful, tending to increase rather than lessen
the renal edema. Under such conditions the patient should be
kept warm and at rest; a very simple diet of low caloric value
may be given. Such articles as oatmeal, rice, apple sauce,
cornstarch, crackers and milk will suffice; the total fluid in-
take should not exceed 1000 c.c. Renal activity will some-
times commence following the application of hot stupes or
cupping over the kidney region or the introduction of some hot
proctoclysis at a temperature perhaps of 115° to 120° F.
This latter acts rather by its heat than as a result of the fluid
employed which may be salt solution of normal or half normal
strength, or even better perhaps a 5 or 10 per cent. glucose
solution. Good results have also been claimed from the in-
travenous administration of glucose solutions; 200 to 500 c.c.
of 10 per cent. solution of glucose may be employed. Still
others have advised the use of alkalies, and this is certainly
indicated if there is any evidence of a lowered alkaline re-
serve.

Diuretics find no place in the treatment of anuria. Digi-
talis which is sometimes classed as a diuretic may be safely
administered, and may be helpful if cardiac weakness is pres-
ent. To some extent compensatory elimination through the
bowels and skin is always to be encouraged, but it is difficult
to decide how energetically one should produce catharsis and
diuresis in a case of anuria unaccompanied by edema or any
uremic manifestations. In such instances it is doubtful if
much is accomplished by more than very moderate purgation
and sweating. If edema or uremia commences to develop the
indication is clear for more active measures which will be des-
cribed in the treatment of these conditions. Occasionally
kidney function is resumed shortly after a venesection or a

hot bath, but it is possible that this is a coincidence. Recent work by Bazett suggests that perhaps prolonged deep hot water baths may prove of value.

Finally if the anuria resists all efforts at relief, the question of the advisability of renal decapsulation should be considered. Decapsulation of one or both kidneys gives relief of the increased tension due to swelling of the organ within its firm capsule, perhaps with unblocking of the lymphatic drainage. This operation is of no value in so-called reflex anuria, but sometimes seems to be life-saving in cases of acute nephritis with marked edema and severe oliguria or anuria. It will be discussed further in the treatment of edema.

TREATMENT OF EDEMA OF RENAL ORIGIN.

Admittedly we are still uncertain as to the exact manner in which disease of the kidney with renal insufficiency brings about edema, and this ignorance handicaps our therapeutic efforts. Many who adhere to some one theory of the pathogenesis of edema include in their treatment of this symptom measures whose only hope of success depends on the correctness of a contradictory theory of etiology. This may perhaps be somewhat justified if there are different causative factors for the edema in different instances, and furthermore there are features such as retention of water which are common to every edema and which may be treated independently of any special theory of etiology.

Mild edema may require no treatment other than that directed at the causative kidney disease. For example, a man of 28 years of age developed in the third week of typhoid fever, a definite albuminuria and many urinary casts. No evidence of renal insufficiency was obvious; the blood-pressure was systolic 110, diastolic 70, the 'phthalein elimination 50 per cent. in a single hour, and the blood urea nitrogen 15 mgms. per 100 c.c. However, on examination a definite edema of the scrotum was discovered which disappeared as the fever subsided. The albumin and casts persisted somewhat longer in the urine. In such cases the activity of treatment can not help being influenced both by the slight degree of the edema, and the probability that the duration of the causative condition would be short.

In other instances, however, the edema may be so extreme as to dominate the picture, threaten life and demand prompt efforts at relief. The exact nature of the underlying renal disease may have to be ignored temporarily and strenuous treatment of the edema instituted.

A patient with much edema should be at rest either in bed or in a comfortable arm chair. Activity should be limited, but the posture may be varied, both for comfort and to keep the edema "on the move." Warmth is desirable both because such patients stand low temperature poorly and take cold easily; secondly, because sweating is to be encouraged. Warmth should be obtained not by heating the room unduly; it is better to supply plenty of fresh air and keep the patient dressed and protected from drafts.

Limitation of fluid should be tried in every case of marked renal edema, with the exception perhaps of instances in which there is also a considerable retention of nitrogenous metabolites in the blood and a very low 'phthalein test; in such cases limitation of fluid is very risky. No arbitrary figure can be set but the consensus of opinion seems to place the level of limitation at about 500 c.c. in the 24 hours. This includes not only the water taken as such, but also that derived from the food. This latter fraction is far greater than is commonly appreciated for not only is the water content of many foods very high, but potential water formation by oxidation must be taken into account; for example, the body obtains more water from a given amount of tomatoes than from a corresponding amount of milk, and almost the same amount of water from equal quantities of milk and beef. An egg contains 74 parts of water and 17 more parts may be formed by oxidation; 100 parts of dry sugar will supply 55 parts of water by oxidation. More water is, therefore, supplied to the patient than is usually measured, and on the other hand more is also excreted; on an average 700 to 800 c.c. are passed off daily through the breath and skin and 100 c.c. at least in the feces. Often these two neglected factors, the water in the food and the water lost in the breath, sweat, and feces, balance each other quite closely but in any accurate study they must be taken into account. Also if by treatment either factor is exaggerated as by diaphoresis or catharsis this effect must not

be overlooked. By simply charting the daily fluid intake and output a curve is obtained which while of practical assistance is far from scientifically accurate. Proper water balance estimation is far too complicated for practical purposes, but a daily record of the weight will enable one to follow the course of an edema and to control treatment. Attempts to draw conclusions from the appearance of the patient are misleading and one will be deceived by the rapid shifting of the edema from one part of the body to another.

The optimum intake of water must be determined for each patient individually and it will be found to vary considerably. Sometimes increasing diuresis results from raising the fluid intake; sometimes a lessened excretion occurs. As a working rule one should start with a liter of fluid a day and observe the result of varying this amount in either direction.

Limitation of chlorid intake is another important measure which may be of great value. Practically it is impossible to give an absolutely salt free diet; one containing only 1 or 2 grams of salt per diem is considered satisfactory. Milk is so often employed in the diet of renal insufficiency that it is worth remembering that it contains 0.16 per cent., or 1.6 grams, of sodium chlorid to the liter. Again one must study the individual case. If it can be shown that the ability of the kidneys to excrete salt is impaired, and if edema lessens on a salt-low diet, it is justifiable to persist over long periods. But prolonged low salt intake may not be without danger and it is often extremely distasteful to the patient. A short period of salt deprivation should always be tried, though the results will often be disappointing. The French school, following Widal, have perhaps overemphasized the value of such reduction of salt. Occasionally an opposite result is obtained and a single dose of 5 or 10 grams of salt will act as a diuretic.

There is a difference of opinion as to the importance of regulating the intake of protein in the treatment of edema. When a retention of nitrogenous metabolites is also present the indications are somewhat clearer, but if there is no such increase in the blood nitrogen there is little evidence that limitation of protein is of value in the treatment of edema. Much harm has probably been done by the persistent use of diets very low in protein, and on the other hand, diets very rich

in nitrogen-containing substances may be dangerous. An intake daily of from 50 to 80 grams of protein will avoid both extremes.

The theory has been held by some for many years that certain instances of edema of renal origin are primarily due to a depletion of albumin. Epstein ardently advocates this view and claims by giving increasing amounts of protein to have relieved suitable cases of long-standing edema of renal origin, which had resisted all other forms of medical treatment. A suitable case is said to present an alteration of the normal ratio of albumin to globulin in the blood, and a high blood cholesterol. In such cases Epstein advises massive venesection and transfusions in order to increase the albumin of the circulating blood, and he administers a diet containing from 120 to 240 grams of protein, 20 to 40 grams of unavoidable fat, and 150 to 300 grams of carbohydrate. Such a diet has a value of from 1280 to 2500 calories, and is to be made up largely of lean veal, lean ham, whites of eggs, oysters, gelatin, lima beans, green peas, mushrooms, rice, oatmeal, bananas, skimmed milk, coffee, tea and cocoa. A number of writers have reported failures with this diet in what appeared to be suitable cases; in several instances the diet had to be abandoned as a result of a steady increase in various fractions of the non-protein nitrogen of the blood.

One of our cases illustrates this point. A man aged 55 years, developed, four weeks before admission to the hospital, an edema of the face, extremities and genitals, without other symptoms. On admission the blood-pressure was, systolic 140, diastolic 80; the urine showed a cloud of albumin, casts, and a specific gravity varying between 1.015 and 1.033; the blood urea nitrogen was 21 mgms. per 100 c.c., the plasma chlorids 5.7 grams per liter, the plasma carbon dioxid 51 volumes per cent., and the 'phthalein elimination 40 per cent. in one hour. The urinary output was constantly below the fluid intake; the weight remained stationary as a result perhaps of free diaphoresis. Various therapeutic measures failed to give any relief, and finally a high protein diet was tried. Increase in the urine and decrease in the edema and weight promptly occurred, but there was a coincident increase in subjective discomfort with nausea and headache, and also a rise in the blood

urea nitrogen and a fall in the 'phthalein. On stopping the high protein diet the patient returned to his former state. Perhaps this case was not well chosen. Apparently if the nitrogen retention is not great and the patient is kept under careful observation a high protein diet may safely be tried, and may in some cases do good, although as pointed out by Kahn, Christian and others, such cases must be very rare.

If the diet conform to the required content of water, salt and protein, in other respects it needs merely to be bland and easily digestible and can be suited to the individual's tastes.

Catharsis to some extent is indicated in the treatment of every case of edema of renal origin, but it is to be used with care and moderation. In an emergency even croton oil may be employed, but as a rule more harm than good is done by very active irritating purgatives. Over enthusiastic catharsis often results in a lessened output of urine and a weakened, anemic patient, subjectively miserable. The chart may temporarily show loss of weight and the edema may decrease, only to re-accumulate as soon as the diarrhea ceases. It is better to cause only two or three fluid movements daily over a long period than intermittently to produce more active results. Often after several weeks of even moderate catharsis improvement in the edema will be evident.

The choice of cathartic is important. Salines such as magnesium sulphate, are widely recommended, but there is evidence that unless the desired evacuation of the bowel occurs promptly and thoroughly, some or all of the saline is absorbed into the body and must then be eliminated by the kidneys. Saline cathartics may thus add to the total salt content of the body and to the work of the kidney, and it may therefore be unwise to use them in the treatment of edema associated with impaired renal function. Even more obvious is the objection to the use of such saline cathartics as contain sodium chloride, for example Hunyadi water, Carlsbad salts, etc. If a saline is given and proves ineffectual it is well to follow it up promptly with some other cathartic.

Calomel is probably not as irritating to the kidneys as has been claimed, but it lends itself poorly to the prolonged maintenance of a mild diarrhea. Chief reliance should be placed

on the vegetable laxatives and purgatives: Cascara, aloes, senna, elaterium, and jalap. It is to be remembered, however, that the official compound jalap powder contains 65 parts of bitartrate of potassium the free administration of which is certainly contraindicated in the treatment of edema of renal origin.

Sweating seldom occurs spontaneously in chronic edema associated with kidney insufficiency but may be stimulated in an effort to rid the body of the edema. Very small amounts of urea, ammonia, and other nitrogenous substances may be found in the sweat, but the chief value of diaphoretic measures lies in the removal of salt and water from the body. If this can be accomplished the use of sweating in edema of renal origin is justified, but our efforts are limited by the ability of the patient to stand the weakening effects of the treatment, and secondly by the fear of producing a dangerous concentration of the nitrogenous or other toxic substances in the body. The rationale of sweating in uremia will be discussed with the treatment of that condition.

Where edema is the only indication for sweating it is best to make haste slowly. One, or at most two, sweats a day are all that a robust patient can usually bear, and often a sweat every other day seems sufficient. The type of sweating to be resorted to is largely a matter of convenience; there seems to be no peculiar virtue in any one method. The hot pack or hot air bath are perhaps to be preferred, although it is sometimes simpler and almost as effective to wrap a patient in hot blankets immediately after a hot bath of from 15 to 20 minutes. The duration of the sweating must depend on the patient's strength and reaction to the treatment. The pulse should be watched throughout and the sweat terminated at the slightest sign of rapidity or weakening. Circulatory collapse is especially liable to occur in cases with myocardial weakness.

During the bath the patient should sip small amounts of cool water, and if the indication is urgent and sweating does not occur a hypodermic of pilocarpine ($\frac{1}{20}$ grain to 0.003 gram) may be ventured.

Diuretics of all kinds, even water in large amounts, find no place in the treatment of edema associated with acute renal insufficiency, but in chronic edema of renal origin they may be

carefully employed. The result should always be watched, for diuretics which do not promptly bring about an increase in urinary excretion may readily do harm if their use is persisted in; even if a short period of diuresis is produced it may be followed by a diminution in renal activity. At such a time the continued administration of the diuretic, even in increased doses, fails as a rule to cause a return of the diuresis, and usually does harm. It is a good rule to use diuretics circumspectly, cautiously and intermittently.

The effects of a diuretic are measured in terms of increased urinary output, and it is assumed that as a rule an increase in the excretion of the various solids of the urine occurs coincidentally. This increase in the excretion of solids is by no means proportional to the diuresis, in fact there is evidence that the urea increases only as the square root of the diuresis and that only to a certain rather moderate limit.

Of the various diuretics which are available, even water, the least irritant, is seldom suitable for cases with edema. As Horder has said, "The time to increase the fluid ingestion is when diuresis begins, not before it has commenced." Sodium chlorid which may occasionally act as a diuretic in these cases is thought by most to be contraindicated, although Fischer employs it in his treatment of edema and nephritis. The so-called "alkaline diuretics," the acetate and citrate of potassium or sodium have fallen somewhat into discredit of late years but are still widely prescribed. Unfortunately our knowledge of the underlying factors in the production of edema is so limited that at present we are not sure whether the occasional diuretic action of the salts of sodium and potassium is the result of an effect exerted locally in the kidneys or in the body tissues in general. Nor is it at all certain that such effect is the result of the alkaline influence of the salt on the hydrogen ion concentration of the tissue fluids; it may perhaps depend on certain properties of the ions of the salt employed. In the treatment advocated by Fischer alkalies, sugar, and salts, including sodium chlorid, are freely administered, but this method has failed to obtain widespread scientific approval, although it undoubtedly succeeds in inducing free diuresis in occasional cases with edema of renal origin. Alkalies may, however, be indicated in the correction of the acidosis which may occur

to a considerable degree in association with renal insufficiency. If administered for this purpose the required dose of alkali should be determined as described by Van Slyke and Palmer, and the result controlled.

The purin diuretics must be one's chief hope, and only too often the hope is proved vain. However, caffein, theobromin sodium salicylate and theophyllin should be tried in the order named which is that of increasing irritant action. If one fails it is no indication that the others will. For example caffein sodio-benzoate in a dose of 0.20 gram or about 3 grains may be given twice a day for two days; if no diuresis occurs and no marked decrease in urine, then three days later theobromin sodium salicylate, 0.6 gram (10 grains) may be administered three times a day for perhaps one day. Assuming that again no result is obtained one may prescribe three days later 0.5 gram (7½ grains) of theophyllin three times a day for one or two days. Even if anyone of these drugs proves successful it should not be repeated for an interval of at least several days. A diuretic which is not producing diuresis should at once be stopped.

When the renal insufficiency is increased and complicated by myocardial weakness, and the edema is in part circulatory as is so often the case in middle aged patients and especially in the obese, then the best diuretic often is digitalis administered freely and combined intermittently with one or other of the purin diuretics.

Thyroid extract has occasionally an unexplained successful action as a diuretic in instances of chronic edema supposedly of renal origin.

Decapsulation of the kidneys, Edebohl's operation, is sometimes resorted to with amazing success in instances of long standing edema of renal origin. Even apparently hopeless cases are occasionally greatly improved, although perhaps only temporarily. When the operation was first advocated it aroused considerable enthusiasm which died away, however, about ten years ago. More recently the literature has again contained a number of reports of successful results; references to a few of these reports are given in the bibliography at the end of this article.

Edema may occasionally be so great in certain parts of the body as to require special local treatment; thus, for example, edema of the glottis may necessitate scarification or an emergency tracheotomy. Edema of the lungs may appear with alarming suddenness and may prove fatal: it is best treated with hypodermic administration of morphin and atropin. Whenever subcutaneous edema becomes unduly marked in any area, especially the lower limbs, it may be reduced by punctures, scarifications or the introduction of Southey's tubes. The greatest care must be taken to avoid infection, which if it develops, may spread rapidly through the edematous tissues and cause a dangerous cellulitis. Occasionally these measures are followed by a most remarkable flow of fluid, but more often the favorable results are trifling and temporary. Edema of the foreskin or penis may interfere with urination, and if elevation of the part does not promptly give relief scarification may be necessary. In every case of edema, even of moderate degree, the skin should receive great care for it is prone to chafe and become infected. Cleanliness, alcohol rubs, and a dusting powder will help keep it in good condition.

Serous cavity accumulations are common and may occasionally be more marked than the subcutaneous dropsy. No satisfactory explanation is known for the predominance of such serous cavity collections as, for example, the early ascites so commonly seen in the edema associated with acute nephritis. Whenever a hydrothorax or ascites causes symptoms it had best be removed by paracentesis. Sometimes following a partial removal a sudden diuresis will further reduce the dropsy. Unless hydrothorax causes dyspnea or discomfort it may be allowed to remain temporarily, but marked ascites even if symptomless should always be removed.

TREATMENT OF UREMIA.

This should be *preventive* and commence long before the appearance of any toxic or preuremic manifestations. It should be instituted in any patient who exhibits a renal insufficiency with any probability of the development of uremia. It should include all measures directed at the improvement of general health, such as the conservative elimination of foci of infection. The patient's activities and habits should be regulated in an

attempt to avoid marked fatigue, circulatory strain, dietary indiscretions, exposure to cold and if possible, acute infections. Efforts should be made to avoid the usual winter "colds" and the gastric or intestinal disturbances which result in vomiting or diarrhea, for even such apparently trifling incidents may suffice to precipitate a uremic attack in a predisposed individual. The diet should be chosen with a view both to easy digestibility and to a moderately low protein content; (50 to 80 grams per diem) this latter is perhaps of especial importance in patients who have exhibited a tendency to an increase in the nitrogen of the blood. At least 1500 to 2000 c.c. of fluid should be ingested daily. At frequent intervals the patient should be seen by the physician, the blood-pressure estimated and the urine examined; and occasionally an estimation of the blood urea nitrogen made. By such observations any change for the worse will be early recognized and more serious developments may be avoided. Rest in bed for a few days followed by a vacation with change of scene will often improve matters. In other instances, however, conditions become steadily worse despite every effort and the patient rapidly or gradually develops uremia.

Once uremia is *threatened* or *present* the most active treatment is indicated. Venesection, catharsis, and diaphoresis are the measures which offer the greatest assistance.

Bleeding is the foremost indication. About 500 c.c. of blood should be removed and if possible replaced by approximately the same amount of normal blood from a donor of the proper group. The chief object of the transfusion is to make it possible to repeat the venesection several times at intervals of twelve or twenty-four hours. Without transfusion repeated venesection is rendered impossible by anemia and weakness, although replacement of the blood by physiologic salt solution will be of some assistance. To what extent such replacement of the patient's blood with normal blood can be carried out is not known; it would seem desirable to go as far as is safely possible.

Active purgation must be produced by whatever means seems preferable. Often magnesium sulphate in a dose of 30 grams (1 ounce) which may be repeated, works admirably and in the absence of edema is not contraindicated. The vegetable

purgatives may be equally efficacious and may perhaps be more easily administered to a uremic patient.   One should not hesitate, however, to have resort to croton oil which in doses of 1 or 2 drops may be repeated if necessary several times a day. Whatever the method, free watery stools must be obtained and if possible continued, but at the same time one must not fail promptly to restore by some route the fluid lost in the fecal discharges.

Fluid must be given freely to restore that lost by venesection, catharsis and diaphoresis and so avoid any concentration of toxic substances in the body, and supply an excess of fluid to maintain as far as possible the renal activity. As a rule in uremia the kidneys can excrete fluids well, but have lost much of the power to concentrate the urine which, therefore, has a low specific gravity and a correspondingly low concentration of solid constituents such as urea and other nitrogenous substances.   To rid the body of any retained nitrogenous metabolites it is necessary, therefore, for the kidneys to excrete large amounts of urine, and water must for this reason be administered freely in uremia.   Even if the ingested fluid is not excreted it may still be of value by diluting any toxic substances retained in the body. If the water can not be given by mouth because of nausea, vomiting or refusal by the patient, other routes must be employed.   The duodenal tube if it can be made to enter the duodenum offers perhaps the best route for the administration of water, fluid foods and drugs.   It avoids the presence of fluid or food in the stomach and so often helps to relieve the nausea and vomiting; it may be left in place for a number of days.   Proctoclysis is usually made impossible by the diarrhea but resort may at any time be had to intravenous or subcutaneous administration of appropriate solutions.   At least 3000 c.c. of fluid should be given daily, and often more is desirable.   Some may be in the form of dextrose solution or other nutritive fluid of low nitrogen content.   During the short period of an acute attack of uremia little food is necessary, but in the chronic cases the patient will require a minimal resting quota at least.

Sweating is the procedure next in importance, and should be promptly commenced upon the appearance of any threat of uremia. Often the patient will have been having, as part of his

routine care, a weekly hot air bath in which he has perspired little or not at all. These individuals respond poorly to diaphoretic measures but in the emergency every effort must be made. The same diaphoretic measures are to be carried out as were described in the treatment of edema, but much more prompt recourse should be had to a hypodermic dose of pilocarpin (0.005 gram—$\frac{1}{12}$ grain). In some instances the hot baths will have to be shortened from the usual period of from 15 to 20 minutes of sweating on account of dyspnea, rapidity of pulse or restlessness, and it is always better to shorten the bath and repeat it later than to persist for the longer period. The sweats may be given twice or even three times in the twenty-four hours according to the condition and response of the patient; occasionally more frequent short sweats are helpful. Even if sweating does not appear in the first bath it may on subsequent trials.

The rationale of sweating in uremia is poorly understood. As was said before, the sweat contains much water and salt but only minimal amounts of urea and the other fractions of the non-protein nitrogen of the blood. There is apparently no direct benefit to be gained in uremia by the removal of water and salt, but it has been suggested that by relieving one kidney function another is enabled to perform better. There is some little evidence that the removal of water and salt acts in uremia by increasing the renal excretion of the various nitrogen containing substances. It has also been suggested that the hypothetical toxic substance which has been assumed to be the cause of uremia may be more freely eliminated in the sweat than, for example, urea. At any rate sweating is commonly believed to be of great value in the treatment of uremia.

Diuretics are least available when most needed, and it is an exceptional case of renal insufficiency with uremia which shows any favorable response to any diuretic except water. Occasionally alkalies may have a diuretic action, but no other diuretic should be tried, for while seldom if ever doing good they may often do serious harm.

In addition to the general treatment of uremia outlined above, special attention is demanded by certain of the symptoms which occur. Convulsions, for example, may respond to the general treatment but sedatives will usually also be re-

quired.   Chloral in full doses is probably the best, although
very good results may be obtained from 0.5 to 1 c.c. of undi-
luted paraldehyde given intravenously, the injection being
made very slowly and requiring about 20 minutes.   Morphia
may be used, and the danger of its effects in renal insufficiency
has probably been exaggerated.   If the convulsions are severe
and repeated, inhalations of chloroform may be cautiously
employed, but it is probably better to try first the removal by
lumbar puncture of a moderate amount of cerebrospinal fluid.
In many cases this gives considerable relief, and from this
fact support is claimed for the theory that edema of the
brain is the cause of certain symptoms in uremia.   During a
convulsion care must be taken to protect the patient from
injury; gentle restraint and a gag between the teeth are
indicated.

Less serious nervous manifestations are often very distres-
sing in the preuremic period and in chronic uremia.   Headache,
insomnia, restlessness, apprehensiveness, and a variety of
psychic disturbances form a group of symptoms which fre-
quently require treatment but never at the expense of the gen-
eral eliminative measures which far overbalance all other pro-
cedures in value.   Quiet in a darkened room, an ice bag to the
head, and the use of sedatives such as sodium bromide and
veronal will often be sufficient.   The headache, however, may
be so severe as to demand the use of morphia or the trial of a
lumbar puncture.   Removal of a few cubic centimeters of
spinal fluid if the intraspinal pressure is high will often give
at least temporary relief.   Occasionally this type of headache
will respond to small doses of acetyl-salicylic acid.   In some
cases the headache is in part due to disturbances of vision and
relief will be obtained from dark glasses and complete resting
of the eyes.

Nausea and vomiting may be extremely persistent and dis-
tressing in early uremia.   Especially severe in the morning
and usually made worse by eating, these symptoms are seldom
benefited by any of the gastric sedatives.   One's hope rests on
improvement of elimination and restriction of diet.   By giving
nothing by mouth for twenty-four hours except small amounts
of cracked ice or by feeding directly into the duodenum
through a tube marked improvement may sometimes be

achieved. Finally one may resort to general sedatives such as chloral or morphia.

Diarrhea should not be checked unless it becomes excessive or blood appears in the evacuations. One should be on the watch for evidences of uremic ulceration of the bowel.

Respiratory distress may be present as a constant dyspnea or in paroxysmal attacks of asthmatic character usually occurring at night. Before accepting the dyspnea as toxic in nature one must exclude other causative factors such as a hydrothorax or failure of the myocardium. Occasionally acidosis plays a part in the production of the dyspnea associated with renal insufficiency, and when this is discovered it should be corrected by the administration of alkali in the amount shown to be required by one of the accepted methods. Morphin is indicated in severe paroxysmal dyspnea and can with benefit be prescribed with atropin. This same combination is the best to employ in acute pulmonary edema. Venesection may also help to relieve dyspnea of any of these types.

Itching may prove extremely distressing and difficult to relieve. Phenol and its derivatives are usually avoided, except in very small amounts, on account of their irritant action on the kidney. Sweat baths sometimes give relief, but often all measures fail.

Anemia may be marked in chronic renal insufficiency associated with uremia, but even more frequently in cases with edema. It is important to watch the blood count after venesection, for anemia may make a transfusion with normal blood necessary. Iron in full doses may be safely added to the routine treatment of all cases of renal insufficiency but arsenic had better be avoided.

Hemorrhagic phenomena may require special treatment. Local applications may suffice when the bleeding is from a single source, as from the nose, for example. When, however, widespread oozing from mucous membranes and the so-called hemorrhagic tendency appears, general measures must be tried although little can be hoped for. Transfusion with properly typed normal human blood should be performed, but in these cases the purpura is of the so-called simple symptomatic type with no reduction of platelet count, and as a rule no treatment is successful.

TREATMENT OF CARDIOVASCULAR DISTURBANCES IN RENAL INSUFFICIENCY.

Various disturbances of the cardiovascular system occur in the course of renal insufficiency and require treatment; at one time extreme hypertension may demand efforts at relief; at another a failing myocardium will require stimulation. The methods to be employed are little modified by the coincident renal insufficiency and the reader is referred to the section on the diseases of the heart and of the arteries. One must, however, keep in mind that the vigor of treatment of the several cardiac or arterial disturbances should always be determined in relation to the renal insufficiency and the existent kidney disease. For example, hypertension associated with failure of the functional capacity of the kidneys must be treated with much greater caution than if the renal function was normal. Patients with hypertension have been thrown into uremia by active measures to reduce the blood-pressure, instituted before the degree of the renal inadequacy was appreciated. Fortunately or unfortunately as it may be, the hypertension in such cases can seldom be reduced except by very vigorous measures. As a rule, however, the blood-pressure in severe renal insufficiency is as often below as it is above, the optimal level of pressure for the functioning of the damaged kidneys. The circulation more often needs support than not, and the integrity of the heart muscle is in chronic renal insufficiency always under suspicion. Much of the eliminative treatment of renal insufficiency, especially when associated with edema or uremia, tends to lower blood-pressure and depress the circulation, and one will very seldom go wrong by administering digitalis. This drug is our mainstay and one need not fear that it will raise the blood-pressure excessively; if the blood-pressure does rise it is probably only to the level which, from the kidney point of view, is the best for the functional capacity of the kidneys in that individual.

PART II.

INTRODUCTION.

In Part I the etiology and symptomatology of kidney disease as a whole were considered, and sections were devoted to the diagnosis and treatment of renal insufficiency. It is proper next to consider certain individual diseases of the kidney insofar as they present themselves as disease entities. The classical pictures of the various diseases of the kidney are largely made up of manifestations of renal insufficiency, and often it is associated complexes such as edema or uremia which are recognized, while the presence of a kidney disease is assumed on this basis. It is true that certain indications of renal insufficiency tend to characterize certain diseases of the kidney, and that from the course, severity and grouping of these disturbances the nature of the renal process can sometimes be correctly surmised. The diagnosis of a kidney disease entails, however, more than can be gained merely from the study of the phenomena of the associated renal insufficiency.

The phenomena of renal insufficiency appear in a variety of combinations in the different diseases of the kidney and confusion often results from this. Furthermore, the individual diseases of the kidney although distinct enough in typical instances are often not very clearly defined. This is especially true of the various forms of nephritis which so merge into one another that no classification, either clinical or pathological, has been wholly satisfactory. Borderline cases occur which are difficult to classify or which will be placed in different groups by the clinician and the pathologist. Confusion also exists between certain types of kidney damage and arteriosclerosis; it has been claimed that many cases called chronic nephritis are merely manifestations of widespread vascular disease. Furthermore, it is contended that certain of the phenomena commonly associated with renal insufficiency may be of extrarenal origin and among these have been considered uremia,

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dropsy and hypertension. If this be true these symptoms of renal disease would not be consequences of renal insufficiency.

The correctness of these views is not proved and meanwhile it is necessary to discuss such forms of kidney disease as appear clinically to be entities. It is on clinical rather than on pathological grounds that the following grouping will be made, and we will avoid a classification based merely on the results of tests of renal function. Many classifications have been advanced and a number of new terms have been suggested as substitutes for the somewhat unsatisfactory term nephritis; none, however, seems to be any great improvement. From the point of view of the clinician the term nephritis is well understood and needs no substitute. The cases appear either as acute or chronic and the latter subdivide themselves into those with and those without edema. Occasionally a case occurs which seems to call for the term subacute, and of course mixed and borderline cases are frequent. Some of the cases of chronic nephritis without edema merge imperceptibly with the late results of arteriosclerosis of the kidney or the so-called arteriosclerotic nephritis. In general this is the classification adopted by Christian and at present it seems to be both the simplest and the most satisfactory.

AGING OF THE KIDNEY AND ARTERIOSCLEROSIS.

The kidney takes part in the changes which occur throughout the body incident to the increasing age of the individual. Oertel has said, "The human organism is never a stable and fixed entity in its parts and organs, and its functions are not uniform but differ qualitatively in various age periods." Such changes in the kidney apparently commence very early in life and may have advanced far by the time the individual has entered the period of middle age. Walsh has demonstrated that the approximate age of an individual can be told by the histological study of the kidney provided it has not been altered by disease. He found that the interstitial tissue at the apex of the renal pyramids increases uniformly with the advancing age of the individual; at the age of one month there is practically none, at nine years of age one or two fine lines have

appeared. These steadily increase in number and thickness like the rings of a tree, until by the age of fifty there are six or eight well marked lines. Further evidence points to a progressive decrease of the actual weight of the combined kidneys after the age of forty. Schlesinger quotes figures to show that at forty the combined weights of the kidneys average 300 grains; during the next ten years this figure falls to 297 grams, in the period from 51 to 60 years it falls to 250 grams, and so on until by the 90th year of life the combined kidneys have an average weight of but 214 grams. Figures far below the average are not infrequently seen at the higher ages. In general this loss of weight is related to the decrease in total body weight, but the kidney apparently decreases somewhat disproportionately, for in youth the kidneys form from 0.50 to 0.75 per cent. of the total body weight while after the fiftieth year they make up but about 0.40 per cent.

The process is a simple atrophy with more or less replacement fibrosis which tends as a rule to affect the cortex a little more than it does the medulla of the organ. As a whole the kidney is smaller and harder and is apt to be pale and anemic. Small cysts protruding from the surface are common. This physiologic atrophy probably results from changes in the arteries and is proportionate to the extent of the arterial process. In the arteries the changes may be thought of as physiologic and incident to the aging of the individual; the process is uniform and balanced throughout the body. In the kidney it is the cortical vessels which seem to be chiefly affected.

No clinical symptoms accompany this renal atrophy as long as it is truly physiologic and proceeds *pari passu* with the balanced aging of the rest of the body, even if it advances to its final stage as the so-called senile kidney. The urine may be wholly unchanged, or it may show a tendency to a somewhat low specific gravity and a small amount of albumin. The functional tests show no deviation from the normal. In other words there is no true disease of the kidney nor any insufficiency of renal functional capacity.

Sometimes, however, the changes characteristic of age occur in early middle life and in such instances it appears that the demands made upon the kidneys are greater than would

be the case in an older individual. Perhaps as a result of this, phenomena of renal insufficiency are more apt to appear in such instances. Undoubtedly the margin of safety in many functions of the body is reduced with the development of the changes incident to age, and there must be a limit to the degree of atrophy which the kidney can undergo without a diminution in its functional sufficiency.

Arteriosclerosis. The arterial changes which occur normally with advancing years may have the term arteriosclerosis applied to them if one keeps clearly in mind that these senile changes are largely atrophic and differ materially from other varieties of arterial change of a pathological nature which may much more seriously affect the kidney and its functional activity. As was said above, the physiologic aging of the arterial system, called "decrescent arteriosclerosis" by Allbutt, may be unassociated with hypertrophy of the left ventricle or hypertension, and the vessels of the kidney may be no more involved than other parts of the arterial system. On the other hand there are other forms of arteriosclerosis of a pathological character. These produce unbalanced and unequal involvement of the arterial tree both in the size of artery affected and also in a tendency to severe lesions in certain localities. One such type peculiarly affects the larger arteries and may present much more advanced lesions in the kidneys, brain or heart than elsewhere. Such cases terminate with the picture of renal, cerebral or cardiac disease respectively. When the kidneys are seriously affected they are apt to be small, hard and irregular; they may be red or pale. The cortex is thinned, the arteries may stand out prominently and throughout the organ an increase of fibrous tissue is irregularly distributed. The clinical picture as well as the pathological may be very similar to that presented by a late stage of chronic nephritis without edema. This pathological arteriosclerotic process occurs as a rule in individuals of middle age and in this differs from the senile changes which usually only appear at a more advanced age. Fahr speaks of a mild and a malignant form of arteriosclerotic involvement of the kidney and his two forms seem to correspond to the two varieties mentioned above. For in the arteriosclerosis of age there is little interference with kidney function unless a failing circulation is also

present, but in the cases of pathological arteriosclerosis of middle age with predominant involvement of the kidneys, the evolution of renal insufficiency and of the complete picture of severe chronic nephritis may be quite rapid.

Essential Hypertension. In middle age hypertension may develop apparently as a primary condition and may persist for some time without any demonstrable arteriosclerosis, nephritis or renal insufficiency. It is possible that in the early stages there is a spasmodic constriction of extensive capillary beds and that later there appears a widespread sclerotic change in the smaller arteries and capillaries. Whatever the nature of the early stages of essential hypertension may be there is no evidence of special involvement of the kidney, there are no symptoms of kidney disease and no abnormality of tests of renal functional capacity. Hypertension itself must not be considered a symptom peculiar to disease of the kidney and in these instances of essential or primary hypertension there is no basis for attributing the increase of blood-pressure to renal disease. Often the hypertension makes its appearance at the climacterium, and in such instances the cause may be some endocrine disturbance. As the process continues the kidneys as well as other tissues and organs commence to show more and more arteriosclerosis of the finer vessels. Sometimes this predominates in a particular organ and the clinical picture of cardiac failure, apoplexy, or renal insufficiency may develop.

When the kidney is thus involved it is apt to be slightly smaller than normal; the cortex is narrowed and the surface somewhat granular. Throughout the organ the blood-vessels of small size are quite uniformly thickened while the larger ones are irregularly involved. Secondary to the arterial disease, changes in the glomeruli and tubules occur, similar to, but as a rule not as uniformly severe or extensive as, those seen in true chronic nephritis. In more severe cases the picture cannot be differentiated from that of chronic nephritis. Symptoms of renal involvement and renal insufficiency may appear insidiously but an amazingly rapid development of severe renal failure is not so uncommon. Sometimes the first warning that a case of essential hypertension is approaching renal insufficiency is given by the occurrence of an albuminuric retinitis. Stengel has emphasized that such cases run a

rapid course and have a very bad prognosis. Essential hypertension may continue with little or no change for years but at any moment the results of degenerative processes due to the impaired arterial supply may make themselves evident in the kidney, heart or elsewhere.

The primary importance of vascular disease not only in the groups of cases just described, but also in those cases of chronic nephritis without edema, which are often classified as chronic interstitial or glomerular nephritis, is emphasized by Moschcowitz who considers them all stages in the progressive development of a primary widespread arterial disease. Whether this be true or not, certainly borderline and mixed cases are frequent and help to confuse the classification. This is true also as regards the autopsy findings. One case may commence with hypertension, another with evident arteriosclerosis, and a third may present from the very beginning evidences of chronic nephritis, all may terminate with similar renal insufficiency and at autopsy may present very similar kidneys of the so-called contracted kidney type. Minor variations, however, are very common so that one who attempts to prophesy the size, color and structural change which will be found at the autopsy in a given case will be often wrong.

Chronic nephritis will be described shortly, and further discussion of the relation of arterial disease to the kidney will be found in the section on diseases of the arteries. Under these headings also will be found a discussion of treatment.

ACUTE NEPHRITIS. (ACUTE BRIGHT'S DISEASE.)

Little is to be gained by subdividing this group into the nephroses and the true nephritides, as is done by so many writers at present. The German authors especially have adopted this classification, and Munk, for example, has carried it to an extreme by describing many subtypes of nephroses. Those who employ the term nephrosis tend to limit its application to purely degenerative processes in the kidney with no proliferative or exudative change. Such renal changes undoubtedly do occur from certain toxic causes, but in other

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instances these same causes bring about proliferative renal changes, either alone or in combination with degenerative processes. Clinically we cannot often differentiate the subgroups nor foretell the character or extent of the process in the kidney. For these reasons the term acute nephritis is still the term of preference. If one wishes to indicate that this condition, if of bacterial origin, is due to circulating toxic substances rather than to the presence of bacteria in the kidney, then the term acute toxic nephritis may be employed.

ETIOLOGY.

Incidence. Acute nephritis is not a common disease after middle age has been reached, and it becomes increasingly rare as old age approaches. Of a recent series of two hundred consecutive cases of nephritis in adults at the Hospital of the University of Pennsylvania only seventeen were acute in type; of these seventeen patients, three were between thirty and forty years of age and three were over forty. It is much more frequent in childhood perhaps because of the higher incidence of the causative infections in early life; perhaps because by the time middle age is reached unsuspected changes in the kidney have taken place which interfere with the development of the picture which we are accustomed to call acute nephritis.

Infections. The part played by infections in the etiology of kidney disease has been discussed in the section on Etiology of Kidney Disease and a brief mention will suffice here. Scarlet fever and diphtheria, which are responsible for a high percentage of the cases of acute nephritis in youth, are both less common in middle age; and such causative infections as smallpox, cholera, and yellow fever, are fortunately rare in this part of the world. The commoner acute infections of middle age are not very apt to produce serious renal damage. Albuminuria, however, is almost constantly associated with fever of more than trifling degree or duration and this should perhaps be considered an evidence of a mild nephritic process in such cases. Munk entitles this "fever nephrosis." It is common in pneumonia, influenza, typhoid, etc., and in any of these conditions a

definite acute nephritis will occasionally develop. Tonsil-
litis, especially of streptococcal origin, is perhaps the most
frequent cause of acute nephritis in childhood and this in-
fection ranks high as a cause also in middle life; Christian
gives tonsillitis as the cause of nine cases, and colds—prob-
ably often with tonsillitis—as the cause in sixteen out of
sixty-six cases of acute nephritis in adults. However, ton-
sillitis also becomes increasingly less common as middle age
is reached and passed; in only three of our seventeen recent
cases of acute nephritis in adults did tonsillitis precede the
onset.

In middle age it is probable that acute nephritis, resulting
from infection, is apt to follow less obvious infectious proces-
ses, for example a flare-up of infection in a chronically dis-
eased gall-bladder, sinus, or tooth socket. A carbuncle or
any localized infection may originate an acute nephritis, and
burns and diseases of the skin seem to possess a peculiar
tendency to bring about this result. On the other hand, it
is interesting to note how seldom rheumatic fever, which
plays such havoc with the heart muscle and valves, affects
the kidneys.

Both syphilis and tuberculosis are said to cause acute
nephritis in adults but it is the author's opinion that such
cases must be much less frequent than some would have us
believe. Some of those attributed to tuberculosis are in fact
due to the secondary infection in the pulmonary cavities,
others are actually cases not of nephritis but of amyloid dis-
ease. Streptococcic bacteriemia, as in streptococcic endo-
carditis, is frequently the starting point of acute nephritic
processes which are sometimes of a special type due to mul-
tiple emboli, and in others of the usual toxic variety, or the
types may be combined.

Whether the acute nephritis which follows exposure to
cold or chilling of the body should be attributed to coinci-
dent infection, as it is by some writers, seems still an open
question. The chilling of the skin was formerly thought to
cause congestion of the mucous membranes, but this has
apparently been disproved. What affect the closure of the
enormous capillary beds of the skin has on the renal capil-
laries is not known; it is probable that the two groups of

capillaries are in intimate relation one with the other, per-
haps acting reciprocally. Even so the relation of this fact to
the onset of nephritis is not clear.   Often, however, a hint
of infection is obtained in a carefully taken history of such
a case.   For example, J. C., white male, aged forty-one years,
was exposed to wet and cold.   Almost at once he noticed
shortness of breath, and later developed cough and chilly
sensations. Six days later his penis became markedly swollen
within a period of three or four hours, and later in the day
his face became puffy.   Another man, aged thirty-one years,
was thoroughly drenched on shipboard, and was unable to
warm himself for some hours.   Sore throat quickly followed.
Three days later he noted marked swelling of the feet, and
in a day or two general anasarca had appeared.   In other
instances no symptom of infection can be discovered.

Non-infectious Agents.   We do not know whether in most
instances infections damage the kidneys through toxic sub-
stances in the circulation or whether the pathogenic organism
actually reaches the kidney and acts locally.   Diphtheria and
cholera, it is believed, produce renal damage by the action
of toxins; streptococci probably act both locally in the kidney
and by toxins.   Chemical irritants need no special discussion;
mercury, arsenic, cantharides, turpentine and a large number
of other substances belong in this group.   Many of the com-
pounds employed in modern industry may prove to have an
irritant action on the kidneys.   Uranium nitrate, which today
is one of the favorite agents for the production of experi-
mental nephritis in animals, was used, not so many years
ago, in fairly large doses in the treatment of human diabetes.
Veronal has been said to cause a very severe form of acute
renal damage with more or less necrosis.   Munk places ver-
onal, salvarsan and bichlorid of mercury in the same category,
all producing a necrosis of kidney epithelium.

Pregnancy.   Acute nephritis may occur in pregnancy.   For
a discussion of the relation of pregnancy to diseases of the
kidney the reader is referred to the section on Etiology of
Kidney Disease (page 534).

PATHOLOGY.

Pathologists recognize a variety of forms of acute nephritis which cannot be separated clinically. It is true that if the etiology is known, the type of change in the kidney can often be correctly anticipated but even this is not always possible. The symptoms, urinalysis and results of functional tests, while enabling us to diagnose acute nephritis, do not enable us to differentiate the subvarieties which are found at post mortem examination. The pathologist differentiates the various types on a basis of the predominance of lesions of the glomeruli, tubules, or interstitial tissue; also according to the character of the degenerative process, the absence or presence of reactive proliferation, and finally on the diffuse or focal distribution of the lesions. But these different forms are often far from distinct and mixed types occur; no matter how the process commences it ultimately must result in a more or less diffuse involvement of the organ. Obviously the gross appearance will vary according to the type and extent of the renal change.

The kidney in acute nephritis is constantly found enlarged, and the capsule strips readily. The swollen organ is usually less firm than normal. The color varies enormously, from extreme paleness to a dark or chocolate red; the organ may be mottled red and white. Glomeruli may stand out as red points due to congestion, and linear or blotchy hemorrhages may be visible. The cortex is normal or widened in acute nephritis and is apt to be poorly delimited from the medulla. At times the focal nature of the process can be recognized on gross examination, and occasionally multiple minute abscesses can be recognized as, for example, in cases of infective endocarditis. Further stages of suppuration resulting from such septic emboli can readily be recognized.

Microscopically an extremely diversified picture may be found which can only be described in terms of the individual component parts of the renal secretory unit. Glomerular changes, which are said to predominate in the acute nephritis of scarlet fever and of streptococcus infections in general, are thought to result chiefly from bacterial emboli, or at least from the local action of bacteria. The process commences in the tufts as a truly inflammatory reaction; the capillaries of

the tuft are filled with blood cells and clot, and soon the
whole glomerulus is infiltrated and the glomerular epithe-
lium is degenerated. If the process is extensive, destruction
of the glomerulus occurs and no regenerative effort is made.
Extension to the tubules and interstitial tissues is not long
delayed.

Tubular changes are apt to predominate in kidneys which
have been subjected to the action of some toxin, as in diph-
theria, pregnancy or metallic poisoning. Milder degrees are
common in many infections, for example, pneumonia. The
epithelial change may be merely a cloudy swelling, as in
febrile cases, or it may run the gamut through fatty and
granular degeneration and desquamation. Disintegrating
epithelium, leucocytes and erythrocytes fill the tubules and
more or less involvement of glomeruli is inevitable. There
early occurs a local infiltration with round cells and eventu-
ally irregular overgrowth of connective tissue takes place.
Regeneration of tubules is attempted but in most instances
probably no functionally capable structure is produced. Cer-
tain changes are quite constantly associated with special
poisons; for example, when syphilis is the cause of the acute
nephritis the degeneration of the tubular epithelium leads
to the appearance of doubly refractile cholesterin esters re-
sulting in what the German writers entitle "lipoid nephrosis."
Lipoid degeneration is frequent, however, in non-syphilitic
cases. Amyloid infiltration, due to long-standing suppura-
tion, may complicate the recovery of a case of acute nephritis,
while calcification in the degenerated tubules is said to follow
in instances due to poisoning with mercury.

Interstitial changes occur sooner or later in all but the
most transitory form of acute nephritis. The proliferation
of connective tissue may be localized or diffuse and may be
slight or extensive. In some instances it is easy to picture
the process rapidly resulting in a secondarily contracted
kidney, in others merely local areas of fibrous tissue result.
In still other kidneys the connective tissue proliferation goes
on but slowly and if the nephritis persists the organ may
remain enlarged and swollen for many months or even years.
This is more apt to occur in cases in which the original
lesions were chiefly tubular. Whether interstitial changes

ever occur alone is a question still discussed. Pathologists describe such a process under the term acute interstitial non-suppurative nephritis, but clinically this cannot be recognized. This subsequent development of interstitial changes following acute nephritis will be discussed under Chronic Nephritis.

SYMPTOMATOLOGY.

In the mildest cases, as for example those incident to some slightly febrile infection, there may be no symptoms other than the appearance of albumin in the urine. Occasionally much more severe grades of acute nephritis may develop insidiously with few or no symptoms except increasing amounts of albumin, casts and blood in the urine. In such instances it is often extremely difficult to decide whether the process is an acute or a chronic one. Sometimes the onset is less insidious but the symptoms may not directly suggest the renal disease. Vague malaise, headaches and slight fever form a not uncommon early picture which may be the result of the same infection which is provoking the nephritis. The nephritis in such instances can be readily overlooked unless the urine be examined.

On the other hand the onset may be marked by one or more symptoms immediately suggesting renal trouble. Of these symptoms hematuria and dropsy stand out most prominently, while oliguria, frequency with irritation, tenderness or pain in the loins, are not infrequently present. Even anuria may occur in severe cases such as those caused by poisoning with bichlorid of mercury, but in adults it is infrequent from other causes. In middle aged individuals the hematuria is not apt to be profuse as in younger patients, nor is the edema apt to be so marked, but these symptoms still remain the most important. The onset of edema may be abrupt and sudden; the patient may become generally dropsical within a few days of the first appearance of the swelling in the face, genitalia or legs. Any combination of the above mentioned symptoms may be seen, and the order of appearance of the different symptoms is very variable. Dropsy has been found before albuminuria and *vice versa;* the same applies to dropsy and oliguria. Ascites is the only

one of the serous cavity collections which is frequent in acute nephritis, the others being more common in the chronic forms.   For the further discussion of edema the reader is referred to the discussion of this topic in the section on Symptomatology of Kidney Disease (page 554).

Uremic manifestations may appear remarkably early in acute nephritis; in fact convulsions are described as an occasional onset symptom, and early nausea and vomiting of uremic origin are said not to be infrequent.   One cannot help suspecting that in all such instances the nephritic process is of a chronic rather than an acute nature, and that an acute exacerbation has led to the mistaken interpretation.   Uremia is not common at any stage in acute nephritis, but may appear, either to pass off again shortly, or to persist to a fatal outcome.

Cardiovascular phenomena are absent in the early stages of acute nephritis; but may appear in an amazingly short time.   The blood-pressure may become elevated and the left ventricle of the heart hypertrophied within a month, it is claimed—certainly within two or three months.   With the development of hypertension its usual results may appear as described in the section on Symptomatology of Kidney Disease (page 563).   Dyspnea is not a common symptom of acute nephritis except in the so-called "trench nephritis" of the recent war.   Trench nephritis is possibly due to a primary infection of the respiratory tract, although there was little evidence of this.   Convulsions also occurred early in trench nephritis, but the course of the disease was usually short and the results favorable.

Within a short time after the onset of acute nephritis most patients become weak and anemic, and unless hidden by edema, loss of weight is evident.   Frequently anorexia, nausea and vomiting are present and help to reduce the general strength.   Although eye-ground changes are very rare, yet the occurrence of an amaurosis is not uncommon.

Physical examination may reveal unsuspected dropsy of the covered parts of the body or of a serous cavity, but in the absence of edema little or no abnormal findings may be discovered.   The facies in many cases has a pasty pallid appearance, and the eye may be very glistening, even before

other signs of edema appear. The tongue is apt to be coated, the breath heavy, but rarely urinous. The eye-grounds, in the beginnings of acute nephritis, show no change, nor do the arteries, heart or blood-pressure. Later, as has been said, the findings approach those seen in chronic forms. In truly acute nephritis, however, the increase of blood-pressure is seldom very great; twenty-five or thirty points increase being, as a rule, the maximum. Nor does more than very slight hypertrophy of the left ventricle appear in acute nephritis. Exceptions to these rules are apt to prove to be instances of acute exacerbations of preëxisting chronic nephritis; or of a nephritic process which has existed longer than is suspected.

Laboratory Examinations. Diminution in the amount of urine is an almost constant feature of acute nephritis of every type, and may occur without the development of demonstrable dropsy. About half the normal output of urine is passed, as a rule. The specimens are often smoky from the presence of blood, or even reddish in color. Albumin is constantly present and may be in such large amounts as to cause the urine to become almost solid upon boiling. The specific gravity is quite constantly as high as 1.020 or over, but occasionally a low figure is found, and this may arouse suspicion of a chronicity in the nephritic process. It is true that hyposthenuria, or the passage of dilute urine, is said to occur in acute nephritis but it is much more common in the chronic forms. Under the microscope a variety of casts and cells are seen. Seldom are casts absent in a fresh specimen but they often disappear soon after the urine is voided, as a result of the rapidity with which the urine of acute nephritis tends to become alkaline. Sometimes they are hidden by the large amount of blood present. At the very onset one may fail to find granular, fatty and waxy casts, but these appear as the nephritis advances. Erythrocytes may fill the field, and may be well preserved, or may appear as shadow corpuscles as a result of partial hemolysis. Occasionally the hemolysis has been complete and a dirty reddish brown sediment is all that remains. Leucocytes, both mononuclears and polymorphonuclears, may be present in such numbers as to suggest that the collecting portions of the urinary tract must be involved by some infection, but at autopsy on some

such cases no pyelitis or similar process has been discovered.
Epithelial cells, from various parts of the kidney and urinary
passages, are usually present in large numbers and may show
various degrees of degeneration.

Anemia of a moderate grade soon develops in most cases,
partly to be explained on the loss of blood in the urine,
partly as a result of the factor causing the nephritis, or of
the nephritis itself. Hydremia incident to the dropsy may
also play a part in producing the lowered count. A slight
leucocytosis is not uncommon but is probably the result of
some primary infection.

Tests of Renal Function. In acute nephritis the results
of functional tests of the kidney are extremely variable and
usually of no very great value in prognosis or treatment.
Apparently contradictory results may be obtained with dif-
ferent methods and as a rule conditions are not favorable for
the performance of many of the tests. The oliguria makes
the collection of sufficient specimens at the correct moment
difficult, and the associated digestive disorders often inter-
fere with the regulation of diet or the administration of test
substances such as urea or sodium chloride. Various tests
of renal function have been described in the section on Diag-
nosis of Renal Insufficiency (page 569), and a brief review
of the usual findings in acute nephritis will suffice here.

The excretion of sodium chlorid in the urine is often very
low, and the output of nitrogen may also be diminished, but
it is usually impossible to accurately estimate from such
measurements the degree of insufficiency of these functions
of the kidney. Similarly any application of the principle of
the Ambard coëfficient is often made valueless by the con-
ditions under which the test has to be carried out. It is
impossible in most cases of acute nephritis to apply the dilu-
tion and concentration tests, and observations of the specific
gravity are of little assistance. Occasionally, however, sim-
ple tests with water, or even the so-called two-hour renal test
can be carried out and as a rule will give evidence of dis-
turbed renal function. This may be so even when other tests
give normal results.

Very variable results are obtained with the phenolsulphone-
phthalein test; the elimination of the dye may be normal

or markedly lowered. In some cases the excretion is un-
usually high and it has been claimed that there is a stage
of acute nephritis in which the kidney is hyperpermeable to
phthalein and certain other substances. At this stage, how-
ever, both salt and nitrogen may be retained in the body.
Reliance can only be placed on the phthalein test if repeated
determinations have been made and the direction of change
observed. An extremely low phthalein test may be found
but a short time before marked improvement occurs; on the
other hand, a normal phthalein excretion may continue while
the patient's condition is becoming more and more serious.
This latter is the exception and as a rule a low phthalein
elimination is found in severe acute nephritis.

Early in an attack of acute nephritis the blood shows no
retention of any of the fractions of the non-protein nitrogen.
Later moderate increases in the total non-protein nitrogen
and urea nitrogen are to be expected, but very marked in-
creases are rare and suggest a preëxisting kidney deficiency.
Perhaps it is the commonly associated dropsy which by dilu-
tion prevents the occurrence of very high figures. In some
of the very severe forms of acute nephritis which are char-
acterized by anuria and an absence of dropsy the amount of
nitrogenous metabolites in the blood may reach a very high
level. The sodium chlorid in the plasma is quite constantly
increased. Further discussion of these tests will be found in
the section on Diagnosis of Renal Insufficiency (page 569).

None of the tests of renal function give results in acute
nephritis which can be consistently correlated with the symp-
tomatic picture or the urine analysis. Christian even claims
that uremic convulsion may occur in acute nephritis with a
practically normal figure for both the phthalein test and the
blood nitrogen. Such cases, however, are fortunately rare.
The variability of the results of functional tests in acute
nephritis can be better realized if one remembers the wide
variety of pathological changes both in type and degree
which are included under this term, and the importance of
the time element for the accumulation of the end products
of nitrogenous metabolism in the blood and tissues.

COURSE, COMPLICATIONS AND PROGNOSIS.

To a great extent the course and result of acute nephritis depends upon the nature and severity of the cause. Many children die of acute nephritis for the reason that the types of the disease seen in early life are severe. In middle age, as a rule, acute nephritis is much less often the cause of death with the exception of those cases due to overwhelming intoxication as with mercury, or when the nephritic process is incident to extensive burns or a serious streptococcal septicemia, as in malignant infective endocarditis. In the severe intoxications the renal lesion is but one manifestation of the action of the poison, and it may be that changes elsewhere will determine the fatal outcome. In such instances death may come in a few days from uremia. As a rule, however, uremia is not so dangerous in acute nephritis as it is in the chronic forms. It is quite possible that there is a fundamental difference in the causation of the uremia in the two conditions.

Mild attacks of acute nephritis may recover in a few days or weeks, and apparently no renal insufficiency be left. Of this, however, we must not be too sure, as chronic nephritis . is probably often the result of a summation of very mild attacks of an acute nature. Even in a mild attack the prognosis must be guarded, for there is always the danger of the sudden development of some complication. Laryngeal or pulmonary edema may unexpectedly bring a fatal issue to a patient who is apparently progressing satisfactorily, and uremia may do the same. Also these patients are liable to pneumonia, pleurisy and pericarditis, any one of which may turn the balance against recovery.

Little assistance is to be had from the tests of kidney function, for even if a marked renal insufficiency is demonstrated, recovery may occur, or, on the other hand, a fatal outcome may be imminent with almost no abnormality of the phthalein elimination or of the blood urea nitrogen. In general, however, it may be said that repeatedly low tests or steadily decreasing function should lead to a more unfavorable prognosis. It is said that special reliance may be placed on an elevation of the blood urea nitrogen despite a low protein

diet. At best, however, prognosis in acute nephritis is difficult.

Recovery may take place after several months of illness, sometimes spontaneously, sometimes apparently as a result of therapeutic measures. When the disease is of such long duration it tends to slip into the chronic form although it may preserve many of its acute features for a number of years. A recognizable transition of true acute nephritis into chronic nephritis undoubtedly occurs but is probably less frequent than some believe.

Illustrative Cases. (1) McV., male, aged forty-seven years. The patient had been in the hospital seven months previously with alcoholic multiple neuritis and at that time had shown no evidence of renal disease. Five weeks before the second admission he had rather suddenly developed cough, dyspnea and edema. The edema became considerable and he was admitted in a serious condition. The blood-pressure was: Systolic, 140; diastolic, 85. 'Phthalein elimination, zero in two hours; blood urea nitrogen, 145 mgms. per 100 c.c. The hemoglobin, 35 per cent. and the erythrocytes 1,860,000. Death occurred shortly. No autopsy was obtained.

(2) C. J., male, thirty-five years of age, caught cold three weeks before admission, and two weeks later developed edema. The phthalein test was forty per cent. in two hours and the blood urea nitrogen, 52. Recovery was uninterrupted.

(3) R. C., male, fifty-six years old. Claimed to have been in good health until six weeks before admission to the hospital. The first symptom was nausea, and this was soon followed by edema, oliguria and dyspnea. There was no history of any factor, infectious or otherwise, to bring on the attack. On admission to the hospital the examination revealed some slight generalized sclerosis of peripheral arteries and marked edema; the heart sounds were somewhat distant. The retinal vessels were sclerosed; the blood-pressure, 155 systolic, 75 diastolic.

Urine analysis: muddy amber, acid, sp. gr. 1.015, albumin a heavy cloud; microscopic examination revealed enormous number of casts of all kinds, occasional erythrocytes, many leucocytes and degenerated epithelial cells, many doubly refractile lipoids both in cells and free.

Other laboratory examinations included: Wassermann, negative; blood count—hemoglobin 50 per cent., erythrocytes 3,700,000, leucocytes 11,100; phenolsulphonephthalein elimination, zero; blood urea nitrogen, 122 mgms.; plasma carbon dioxide, 36 vols. per cent.; blood chlorides, 6.4 grams per liter; carbon dioxide tension of alveolar air, 25 mm.

The patient steadily grew worse and two weeks after entering the hospital sank into uremia and died after three days of unconsciousness. At autopsy the kidneys exhibited a process which seemed to be less acute than the length of the illness described in the history would justify. The tubules were severely damaged, the glomeruli almost normal. The capsule was quite adherent, the surface irregular and considerable subcapsular fibrosis was present. Grossly, the kidneys were large and pale.

(4) A. S., aged twenty-two years, developed an attack of acute nephritis following an acute tonsillitis. She had had tonsillitis off and on for many years and the tonsils were chronically diseased. On admission the urine was found to contain much albumin, blood and many casts. The phthalein elimination was thirty-six per cent. Recovery was satisfactory.

DIFFERENTIAL DIAGNOSIS.

The three conditions most likely to lead to confusion are: hematuria from some non-nephritic cause such as calculus, passive congestion of the kidney, and thirdly, an acute exacerbation of a chronic nephritis.

Hematuria is seldom the only evidence of an acute nephritis but it may be the "presenting symptom" for a considerable time. On complete investigation, however, the presence of an acute nephritis as the cause of a hematuria can scarcely be overlooked. An error of diagnosis would be easily possible if one failed to remember that acute nephritis may bring about a constant and severe hematuria which, however, is apt to be more marked in children than in adults. Other causes of hematuria are tuberculosis or tumor of the kidney, calculus, polycystic kidney and circulatory disturbances in the kidney. It is not likely that the hematuria due to any

one of these causes would be mistakenly attributed to an acute nephritis.

Passive congestion of the kidney will produce a diminished urinary output, a high specific gravity, and the presence of albumin, casts and a little blood in the urine. Edema may also be present as a symptom of the same circulatory weakness which is causing the renal congestion. The sequence of events in the development of the picture and the physical examination should remove all confusion; the edema will present the characteristics of circulatory edema in its distribution, behavior and response to digitalis.

An acute exacerbation of a chronic nephritis may perhaps more properly be termed an attack of acute nephritis superimposed on a chronic process. It is obvious that the recognition of the presence of the chronic nephritis may be the only distinguishing feature between such an exacerbation and a primary attack of acute nephritis. The patient's history may tell the story, or on physical examination the heart may be found too much enlarged or the blood-pressure too elevated for a primary acute nephritis, and one's suspicions will be aroused that a chronic process is also present. In other instances the degree of renal insufficiency left behind when recovery from the supposed acute attack has taken place is so disproportionate as to suggest that the kidneys had previously been damaged. At the height of the acute attack tests of renal function will not help us differentiate between these two conditions. A tendency to a low specific gravity in the presence of what seems to be an acute nephritis may give us a hint, but too much reliance must not be placed on this point. The size of the heart is the most helpful indicator of the chronicity of the renal process, and some help may also be had from the degree of arterial change and the level of blood-pressure.

TREATMENT OF ACUTE NEPHRITIS.

Prevention of renal damage should always be prominently in our minds whenever a patient is suffering from one of the infections or intoxications which are frequently complicated by an acute nephritis. Much can be accomplished in this

direction by insistence on adequate rest and warmth, limited diet and free fluid intake. Careful treatment of acute infections will suffice to prevent certain instances of kidney disease, and if renal irritation unavoidably occurs, then by rest, warmth, suitable diet and large amounts of water one may try to lessen the harmful results. Especially is the dilution of the circulating toxins, be they of infectious origin or otherwise, of importance.

By removing foci of chronic or recurring infection, especially such foci as exist in the mouth and throat, the likelihood of acute nephritis can be reduced. This applies with even greater force to individuals who have had one attack of acute nephritis following, for example, a tonsillitis. It is needless to add that every precaution should be taken to avoid the occurrence of acute nephritis as the result of chemical intoxication with any of the various irritants, some of which are to be numbered amongst our medicinal agents.

Treatment of established acute nephritis is a combined effort to remove the cause, relieve and protect the kidneys, support the patient, and vigorously combat any evidence of renal insufficiency which may appear.

Removal of the cause is analogous to prevention and the same remarks apply. If the infection can be lessened or relieved as is the case with many focal infections and some generalized ones, the appropriate treatment is clearly indicated and it should be carried out promptly and thoroughly. Where both the infection and its curative agent are renal irritants one had best proceed cautiously but unhesitatingly to treat the infection. This is particularly true when active syphilis and nephritis coexist; when this is the case the syphilitic nature of the nephritis can often only be determined by a therapeutic test. In intoxications causing acute nephritis further damage may be prevented if the causative substance is recognized, as for example mercury, cantharides or turpentine. Endogenous toxemias, as for example in pregnancy, may require active treatment for the relief of a complicating acute nephritis.

Under the heading of relief and protection of the kidneys come such details as rest in bed, warmth, diet, fluid intake, hydrotherapy and drug medication, each of which will re-

quire brief discussion. It is easy to say that the patient should be kept in bed until acute manifestations subside or until two weeks after erythrocytes no longer are present in the urine but this would sometimes result in the patient's spending three or four months in bed with perhaps more harm than good. The matter will often have to be settled according to the individual case and the surroundings. A minimum of a month's stay in bed is probably conservative and during this period the patient is carefully protected from chilling although supplied with fresh air. After a month the severity of the case will be obvious and further rest may be clearly indicated or, if the attack has been mild and has apparently subsided, the patient may be gotten out of bed for short periods daily. If well protected from cold and over-exertion this will do no harm and will often go far to improve appetite, sleep and morale in general. Eventually some cases present the problems which will be discussed under the treatment of chronic nephritis.

Dietary regulation is always important and usually difficult in patients with acute nephritis; some rebel against marked restriction, while others suffering from nausea and loss of appetite take even the most limited diet unwillingly. In this latter group a twenty-four hour fast with fluid administered by bowel will often improve matters, while in the former group persuasion on the basis of the evidence presented by their symptoms will frequently be sufficient. In general the diet should be adequate for the needs of the patient and yet demand as little excretory action as possible on the part of the kidneys. For this reason it is usual to markedly reduce the amount of protein and salts and to moderately reduce the amount of fluid. The French have a maxim concerning the diet in acute uremia which might be applied as well to acute nephritis: "Lait ou mort," and many believe that at least during the most acute stages a diet limited to milk is the most satisfactory. At least a liter has to be taken to supply even 700 calories and this amount contains an obviously large amount of water and at least 30 grams of protein and 1.5 grams of sodium chlorid as well as considerable quantities of phosphates and sulphates. For these reasons some do not approve of the milk diet and either modify it by the addition

of such substances as fruit juices, thin gruels, unsalted but-
ter, crackers, white bread, rice and potato, or make the whole
diet out of such food stuffs. From this group of articles in
varying daily combination an adequate diet can readily be
arranged which will contain from 1800 to 2000 calories, 20
to 30 grams of protein and not more than 2 or 3 grams of
salt. Water or other fluids may be added to bring the fluid
intake up to the desired level.

The question of the possibly harmful results of limiting
protein intake has been discussed in the section on Treatment
of Renal Insufficiency, under the Treatment of Edema (page
591). But for a short period during the most acute stage of
acute nephritis there is no contraindication to a very low
protein diet. Under the same heading further discussion of
salt-low dieting will be found. Even if edema is not great
salt should be limited during the acute stages, but may then
be given more liberally unless edema persists. Neither the
milk diet nor the other diet just detailed should be persisted
in for more than a few weeks, without considerable variation,
not only in order to avoid monotony but also in order to
be on the safe side in supplying all the necessary dietary
factors to the patient. As the acute manifestations quiet
down little by little the diet may be gradually made more
liberal along whatever lines seem safest. By this time one
will know whether the patient is showing a tendency to ac-
cumulate nitrogen in the blood or to become excessively
edematous, and from the symptomatology and the tests of
renal function one gains a hint as to the safest line of
procedure.

Fluid Intake. Unless edema is marked there is no good
reason for strictly limiting the fluid taken by the patient and
at least a fair amount seems indicated. On the other hand,
excessive administration of fluid may in many instances actu-
ally do harm. A reasonable amount seems to be a liter or a
liter and a half, although variations in either direction may
seem indicated in individual cases. If much fluid is being
lost by diarrhea, vomiting, or sweating, it must be replaced
and the urinary excretion kept up to as satisfactory a level
as possible. Most cases of acute nephritis will pass a dimin-
ished amount of urine and the optimal amount of ingested

fluid will be that which results in the largest urinary output with the least retention of fluid. Whether, for example, it is preferable for a patient to receive 1000 c.c. and pass 500 c.c. of urine or to receive 2000 c.c. and pass 800 c.c. will often have to be decided for the individual case. In the former instance only 500 c.c. of urine is passed; in the latter more urine is excreted but probably also more fluid is retained. The tendency to dropsy or to uremia may settle this matter and a further discussion of this point will be found in the section on Treatment of Renal Insufficiency (page 590).

Water may constitute the greater amount of the fluid given; alkaline mineral waters, lemonade and milk may be substituted. When nausea interferes with the administration of sufficient fluid, appropriate solutions may be given by proctoclysis, through a duodenal tube or intravenously.

Hydrotherapy is not urgently indicated in acute nephritis unless evidence of renal insufficiency, dropsy or uremia develops. The indications for the use of diaphoretic measures in dropsy and uremia are discussed elsewhere. Even in the absence of edema or of increase of nitrogen in the blood, an occasional mild sweat may help to avoid the development of these complications. A five-minute sweat, given once a day or every second day, is good practice in any stage of acute nephritis.

Catharsis. What has been said about sweating applies with equal force to the use of cathartics. Moderation is indicated unless dropsy becomes severe or uremia threatens.

Diuretics are not indicated in uncomplicated acute nephritis. Their use when dropsy or uremia develops is discussed under the treatment of those conditions.

Decapsulation of the kidneys is seldom indicated in acute nephritis unless the attack is very severe and associated with extreme oliguria or anuria. Occasionally under such conditions the operation results in a marked diuresis and improvement. Also when the attack has persisted for months and despite all medical treatment seems to be entering on a subacute or chronic stage with marked anasarca as the chief symptom, then decapsulation should again be considered. (Cf. Treatment of Renal Insufficiency, Treatment of Edema, page 596.)

CHRONIC NEPHRITIS.

Under the heading of chronic nephritis must at present be included cases of very different etiology, history and symptomatology. On the one hand, there are those which undoubtedly develop from a recognizable acute attack of nephritis; on the other hand, some make their first appearance as a chronic process, some are characterized by marked edema and little hypertension, others by hypertension with little or no edema. At one end of the scale the case picture merges imperceptibly into that of acute nephritis; at the other end with arteriosclerosis of the kidney. And yet it seems, from some points of view, best to group them all together under the one heading.

ETIOLOGY.

It is safe to say that in the vast majority of cases of chronic nephritis it is impossible to discover the etiology. Enthusiasts for any one causative factor seem always to be able to point out a high percentage of instances in which that factor has been present, but this is not proof of a causal relationship. There is little doubt that the importance of focal infections has been overemphasized in some connections and it is exceptional to find an individual of middle age who, on rigid examination, does not reveal some focus of infection.

Recognizable acute nephritis precedes the development of chronic nephritis in some instances, but the number is not great. Sometimes the acute process gradually fades out into the chronic form, but more often the acute process is apparently entirely cured and the chronic nephritis becomes evident, sometimes very abruptly, after a period of years during which there has been no hint of renal disease or kidney insufficiency. The remarks made in the section on Etiology of Kidney Disease (page 527), on the subject of scarlatinal nephritis, apply in this connection. When chronic nephritis thus follows an acute attack after a lapse of years, three possibilities present themselves: either the two nephritic processes bear no relation one to the other, or the primary attack weakened the kidneys and made them susceptible to influences tending to a chronic nephritis, or finally the chronic

nephritis may be thought of as merely the inevitable ultimate outcome of the pathological process initiated during the acute attack. Whatever view is adopted, however, acute nephritis must be included among the causes of chronic nephritis and the causes of acute nephritis become indirectly those of the chronic process. Undoubtedly in many instances such causative factors may never act with sufficient intensity to produce an obvious acute nephritis, but acting over a longer period, or repeatedly producing an inconspicuous and short-lived acute process, finally the renal damage may be the same. Emerson has recently emphasized the frequency of such acute incidents in the development and course of chronic nephritis. This point of view pictures chronic nephritis and its associated renal insufficiency as the summation of repeated acute insults, each reducing the functionating tissue of the kidney until at length the organ is insufficient. This same view might be held for the action not only of infections and infectious toxemias but also for intoxications of various kinds.

Hereditary factors and congenital influences have been discussed previously and need not be repeated here. In the same place the question of diet is also considered. Although the influence of food on the production of nephritis may perhaps be of great importance, unfortunately little is known with certainty. Excessive protein food, highly seasoned food, too much salt, too much food, and insufficient fluid, have all been advanced as factors in the causation of chronic nephritis. The evidence of renal irritation following large amounts of protein food is good; the action of the other factors is problematical. Nor is there any very good evidence for the belief that the products of poorly digested food damage the kidneys. Constipation has also been accused on very inadequate evidence.

When one discusses the causal relationship of such chronic intoxications as those with lead and alcohol, one meets with difficulty due to confusion between the effects of the toxins on the kidney directly and on the arterial system. In middle aged patients, especially, the coincidence of arterial disease with chronic nephritis is frequent, and even if a possible cause is present one is in doubt as to whether its action has been on the kidneys or arteries. Arteriosclerosis and

chronic nephritis are intimately related and clinically often cannot be differentiated. Often their relationship is confused in a given patient and it is impossible to distinguish cause and effect. (Cf. Aging of the Kidney and Arteriosclerosis, page 605.)

A discussion of other possible etiological factors, including gout, pregnancy, syphilis, diabetes mellitus, overwork and the secondary effects on the kidneys of chronic passive congestion and of chronic obstruction of the lower urinary passages will be found in the section on Etiology of Kidney Disease (page 523).

PATHOLOGY.

In any consideration of the pathology of chronic nephritis one must keep clearly in mind, not only the various inflammatory and degenerative changes which appear in the acute stage of nephritis, and the localized or diffuse fibrous tissue proliferation which later increases the normal renal connective tissue and replaces areas of destroyed parenchyma, but also the changes which result from primary arterial disease of the renal vessels. These several features must be remembered for it is from these components in varying proportions that the different pathological pictures of chronic nephritis are formed.

In one instance the process which culminated in a chronic nephritis may have commenced as an acute nephritis, with preponderating damage in either tubules or glomeruli and with a varying amount of interstitial connective tissue proliferation. As such a process continues the kidney becomes diffusely involved and as a rule the reactive fibrosis progressively increases. It may at first be an acute nephritis, later a subacute and finally a chronic nephritis; Volhard recognizes three stages of an unhealed nephritis: the subacute, the subchronic, and the wholly chronic. The organ may remain enlarged long after the disease has clinically passed its acute stage; the large white kidney of such a case is pale and on section the individual glomeruli are often visible as minute pale or congested spots. The cortical markings may be indistinct and scattered hemorrhages may be present. If, however, connective tissue formation is extensive the kidney

ceases to be as large, the capsule becomes adherent and the surface irregular. The cortex suffers most and becomes markedly irregular, uneven and scarred and into the pittings of the surface the capsule dips and is adherent. Occasionally the fibrosis is sufficiently diffuse to leave the surface smooth, but this is rare. In the deeper portions of the kidney the young fibroblastic cells between the tubules have matured and firm thick connective tissue bands replace degenerated and atrophied parenchyma and by contraction distort the remaining tubules. The exact state of the individual glomeruli and tubules is in part still dependent upon the nature of the original process, but many units have atrophied as a result of interference with function and nutrition, and show advanced stages of degeneration or are more or less completely replaced by fibrous tissue. By the time connective tissue overgrowth has become extensive the organ has become progressively reduced in size and presents itself as a form of contracted kidney. Whether it is pale or red is a matter of no very fundamental significance, but depends on the extent to which increased vascularity, hemorrhagic extravasations and venous congestion are present.

When the primary process has been of the type with extensive glomerular involvement there is a far greater likelihood of a subsequent chronic nephritis, and the tendency to irregular fibrosis and secondary contraction is far greater. True glomerulo-nephritis seldom fails to be followed by more or less permanent destruction of glomeruli and fibrous tissue proliferation. It is uncertain, however, whether such a chronic nephritis is ever the continuation of a single acute attack or whether it develops from a truly progressive degeneration due to the end results of an acute attack. An alternative view is that repeated acute injuries to the renal parenchyma lead to repeated scarring and progressive reduction in the functional capacity of the organ. According to this view there occurs a permanent damage which is increased with each new attack, and an acute element which at intervals reappears, perpetuates the disease, and by increasing the permanent damage ultimately results in renal insufficiency. Chronic nephritis, according to this view, ex-

ists from the time of the subsidence of the first acute attack, but renal insufficiency may never appear or at least not for many years. This is an important conception from the standpoint of the prevention and treatment of chronic nephritis. It offers a hope that by the avoidance of further acute insults a chronic nephritis if recognized early may be prevented from going on to serious renal inadequacy. There is nothing in this hypothesis that is incompatible with the pathological findings in the kidney of chronic nephritis.

In chronic nephritis of any type the glomeruli seldom escape and in those instances that commenced with glomerular lesions the final stage will show few of these structures still normal in appearance. Many of the glomeruli will be wholly replaced by fibrous tissue, others will show thickening of the wall of the glomerular capillary and various degrees of thrombosis. Some of the glomeruli appear to have hypertrophied, and more or less proliferation often occurs, with the result that the enlarged capillary tuft is often seen to be adherent to the glomerular capsule. Certain of the changes are identical with those seen in an acute nephritis, others, such as the hyaline fibrosis, are on the contrary end results. The tubules corresponding to the disabled glomeruli are atrophied and degenerated, and perhaps replaced by connective tissue.

The vascular apparatus of the kidney is sure to be interfered with sooner or later, but in the chronic process which has apparently continued from an acute diffuse nephritis and has passed through the stage of the large white kidney, there may be little or no disease of the renal blood-vessels, nor is the blood supply obviously impaired until fibrous tissue overgrowth has become extensive. As a rule such a kidney is small and pale. On the other hand, in predominantly glomerular nephritis there may early occur an associated obliterating endoangeitis, and the extensive fibrosis which soon appears, leads to further vascular difficulties. This kidney is more apt to present a red or at least mottled appearance. Arterial disease of the intrarenal vessels of an arteriosclerotic nature may, and in the middle aged often does, complicate a chronic nephritis. The very close relationship of arterial disease and chronic nephritis has been mentioned already

and is more fully discussed in the section on diseases of the arteries.

Vascular disease in the kidney, whether primary or associated with nephritis, reacts unfavorably on the renal parenchyma. Interference with the nutrition of the renal epithelium may be responsible for much of the cellular degeneration which is usually considered part of the nephritis. Venous stasis is another important factor which is often superadded in chronic nephritis.

SYMPTOMATOLOGY.

Chronic nephritis may present a number of very different clinical pictures which should always be considered and interpreted in terms of renal insufficiency, since most of the symptomatology and the physical findings in chronic nephritis are explainable by one or other phase of renal insufficiency or its associated manifestations. In one instance it is dropsy; in another, uremia, and in still a third, cardiovascular phenomena. Chronic nephritis is known by the renal insufficiency it presents. And yet, renal insufficiency is not the whole story, for by the term chronic nephritis more is meant than simply a failure of the functional capacity of the kidney. Chronic nephritis implies also extrarenal factors and the question of duration and progression enter in.

Any combination of the results of renal insufficiency may occur in a given instance of chronic nephritis, but no case presents them all. One cannot, however, dogmatically state that such and such symptom groups never occur together; edema, hypertension and uremia may be combined in an infinite variety of clinical pictures. Certain combinations of symptoms, however, form the commoner syndromes of chronic nephritis. Two deserve special mention: the one is characterized by dropsy, marked urinary changes, and interference with elimination of water and salt; the other by hypertension, cardiac hypertrophy, retention in the blood of nitrogen, and uremia. In both there is a variable degree of renal insufficiency but of very different character, and all sorts of borderline cases occur. In both the onset may be very insidious and the cause undiscoverable.

Chronic nephritis with edema is increasingly uncommon after middle age is reached and needs but brief mention in the present discussion. Schlesinger states that in his series of autopsies on the elderly, the type of kidney usually associated with edema was found in only 2 per cent. of the whole number. In some instances this type of chronic nephritis can be traced back through a subacute stage to a primary attack of acute nephritis. In another case an apparently acute attack may terminate fatally and at autopsy the kidneys will be found to exhibit changes which clearly establish the presence of a chronic process.

Chronic nephritis with edema is usually associated with a kidney which still possesses more or less of the characteristics of the large kidney of nephritis to which may be added more or less fibrous tissue proliferation and contraction. All intermediate stages between this and the secondarily contracted kidney occur and the clinical picture varies accordingly. Symptomatically the picture is usually dominated by dropsy which may remain stationary for months at a time or may fluctuate from week to week. In many instances the anasarca is excessive and the patient becomes a "swollen parcel of dropsies." In the section on Symptomatology of Kidney Disease will be found a more detailed description of dropsy which is applicable to this form of chronic nephritis. Other symptoms are apt to be less evident; a vague ill health, anorexia or headache may precede the dropsy. Digestive symptoms are frequently present and may be severe, but they are variable and not characteristic. Vision is not commonly affected; albuminuric retinitis is rare and retinal hemorrhages are less common than in chronic nephritis with hypertension. Nervous manifestations and uremia are not the rule in typical cases, nor does this type, as a rule, present much hypertension, cardiac hypertrophy or arterial disease. When the process approaches the contracting stage the picture tends to be correspondingly altered and a tendency to hypertension and uremia becomes more evident. Amazing exceptions, however, occur in either direction. Anemia is common but is apt to be more apparent than real.

The changes in the urine are, after the dropsy, the most characteristic feature of chronic nephritis with edema. The

amount is diminished sometimes to an alarming degree, al-
bumin is present in considerable amounts, and an enormous
number of casts of all varieties are the usual findings. Red·
blood cells are frequently present in small numbers; leuco-
cytes are apt to be numerous. Fat droplets and doubly re-
fractile lipoids are usually present. In the blood there is
found increase of the fats and of cholesterin, low serum
albumin and relative increase of globulin.

Chronic nephritis without edema is the form of chronic
nephritis characteristic of middle age. It is of great im-
portance not only because of its apparently increasing fre-
quency, but also because of its serious results. As a rule
the onset is extremely insidious and the process seems firmly
established before its presence is recognized. Sometimes,
however, a history of a preceding attack of acute nephritis
gives a hint as to the beginnings of the trouble, but far more
often no suggestive history can be obtained. Indeed, it is
not uncommon for the condition to be discovered by acci-
dent in a middle aged individual who denies every etiological
factor and who claims to be and to have always been in
excellent health.

Chronic nephritis without edema is quite constantly asso-
ciated with the small, irregular, contracted kidney which has
already been described. It must, however, be remembered
that this is an end stage which may have been arrived at via
any one of several routes; inflammatory changes may have
terminated in secondary ʻcontraction, or arterial disease may
have led to much the same result. Several references to these
alternatives have been made already and the reader is espe-
cially referred to the section on Aging of the Kidney and
Arteriosclerosis.

Symptomless as the onset may be, questioning will usu-
ally elicit an admission of ill health. This may have been
very slight and indefinite, nothing more perhaps than an in-
creased tendency to fatigue and a loss of energy. In others
the first evidence is found in a changed disposition; perhaps
an increasing irritability or depression. With these phe-
nomena there may or may not be associated an actual loss
of strength and weight. Such patients are often thought to
be merely "nervous."

Of the more definite symptoms which often occur early,
headache is the most frequent and important. It may pre-
cede all other symptoms by a long period, it may be inter-
mittent and seem to be related to constipation. It is usually
dull rather than severe in nature and the patients often speak
of it as "congestive." Indefinite digestive symptoms are very
frequent but not characteristic. Often a bad taste in the
mouth is complained of and anorexia, flatulence and disten-
sion after meals.

At this early stage the only positive feature may be the
presence of albuminuria with a tendency to an increased
amount of urine of low specific gravity. Sooner or later,
however, evidences of cardiovascular disturbance and of a
tendency to uremia make their appearance. In fact it is not
certain that even the vague symptoms of the onset do not
have their origin in an associated cardiovascular derange-
ment.

Ultimately the picture is dominated by symptoms arising
from hypertension and circulatory failure, or by the toxic
manifestations of incipient or established uremia. In one
instance the circulatory phenomena are prominent; in an-
other the symptoms of uremia, while in a third there may
be a combination of the two. Towards the end of the disease
a variety of symptoms—dropsy, hemorrhagic phenomena,
emaciation, vomiting—may appear but all find their expla-
nation in the circulatory disturbance or in a uremic tendency.
Whether these factors are directly due to renal insufficiency
or are the results of extrarenal factors is discussed elsewhere,
and a further description of these cardiovascular and uremic
manifestations is given in the section on Symptomatology
of Kidney Disease (page 557).

There may be no change in the patient's appearance in
the early stages of this disease, and the facies may be appro-
priate for the age, but in some instances the face will appear
drawn, the expression tense and tired, and the patient some-
what older than the actual age. The skin tends to be dry
and sallow; the loss of weight may be considerable, even
early in the disease. Unfortunately by the time the disease
is first recognized there is usually present some degree of
hypertension which may even be extreme and this may be

appreciated by palpation of the pulse although the absence of any obvious arterial change as yet may lead to the increased pressure being overlooked. Blood-pressure records will reveal the true state of affairs and one may be amazed to find that an apparently healthy middle-aged individual has a systolic pressure of from 180 to 200 or more, with an increase in the diastolic to perhaps 100 millimeters of mercury.

Cardiac hypertrophy will not be demonstrable early, but will inevitably appear as the case progresses; it is apt to seem to be more left sided than right, but eventually both are involved. So long as the cardiac muscle is adequate and the pressure high, the muscle sounds will be normal, the second aortic accentuated and there will be no murmurs heard. Later a mitral systolic murmur, poor muscle tone, extrasystoles, gallop rhythm, and perhaps finally auricular fibrillation evidence the myocardial failure. At this late stage, edema of circulatory origin may confuse the picture, and varying degrees of dyspnea may be present.

In some cases arterial thickening may be found at an early stage and this may be peculiarly evident in the retinal vessels. Ophthalmoscopic examination of the eye-grounds should not be neglected in the routine examination of the middle aged for retinal hemorrhages or even albuminuric retinitis may be unexpectedly discovered.

In late cases the physical examination may reveal nothing further, but the features already mentioned are apt to be more marked. At this stage the physical appearance is most characteristic, the emaciation tends to be extreme, the eyes somewhat prominent, the skin somewhat pigmented, the tongue coated and the breath urinous. Extreme degrees of hypertension, cardiac hypertrophy and arterial disease may be present. Other findings, such as hemiplegia or hemorrhagic manifestations, are due to the hypertension or the toxemia.

The urine in chronic nephritis without edema is quite constantly increased in amount and often continues so during the development of uremia and even until a fatal outcome, unless circulatory weakness reduces the amount. As a rule the twenty-four hour quantity varies between 1200 and 2200 cubic centimeters, of which a greater than normal proportion

is passed during the night. Its color is pale and its specific
gravity tends to be fixed at a level of from 1.008 to 1.014.
Albumin is usually present but not in large amounts and not
constantly. Casts also are not present in great numbers and
are usually of the hyaline or granular variety. None of the
evidences of a severe degenerative process are present. Leu-
cocytes are few and red blood cells variable; occasionally
hematuria is quite marked.

Urinary changes may precede all other symptoms and often
it is the discovery of albumin and casts at a routine or life
insurance examination that first raises a suspicion of this
disease. For years the urinary changes may continue with-
out other evidences of the nephritis, but eventually and some-
times very abruptly, the other manifestations of the disease
and of renal insufficiency appear.

Tests of Renal Function in Chronic Nephritis. The evi-
dence presented by the various tests of renal function varies
according to the type of the chronic nephritis and the stage
and severity of the process. Having divided chronic nephritis
on a symptomatic basis into two groups, one characterized
by dropsy, and the other by hypertension and a tendency to
uremia, it is obvious that the results of the various functional
tests will be correspondingly different. The symptom and
the impaired functional test have a common explanation.

Chronic nephritis with edema shows definite interference
with the elimination of water and of sodium chloride; both
are retained in the body. This is early evident and can be
demonstrated by any of the usual methods. The degree of
disturbance tends to be variable and it gives little or no help
in prognosis. Phenolsulphonephthalein elimination is seldom
normal, but the decrease is usually not extreme nor is it more
than roughly proportionate to the severity of the disease. In
the blood the sodium chloride may be high but this is incon-
stant and not always in accord with the degree of edema;
typically the blood urea nitrogen is not elevated, or only very
slightly so, unless the diet has been very rich in protein.
Late in the disease the specific gravity may tend to be fixed
at a lower level and retention of nitrogenous metabolites may
occur. Such cases present features common to both types

of nephritis, and the kidneys are probably approaching the secondarily contracted stage. All gradations are seen.

In the type of chronic nephritis without edema the tests which reveal the impairment of renal functional capacity are those which are concerned with the organ's ability to concentrate the urine, the phthalein test and those which give evidence of nitrogen retention in the blood. The kidneys' response to the various tests with water and with sodium chloride may be entirely normal, but no reduction in fluid intake results in the passage of urine with a specific gravity of over 1.015 nor can free ingestion of fluid dilute the urine below about 1.008. The more advanced the case the more strictly will the specific gravity be fixed in the neighborhood of 1.011 to 1.013. At the same time the percentage of phenol-sulphonephthalein which will be eliminated in two hours will have dropped from the 40 per cent. seen early, down to 10 per cent. or even zero; this latter low figure may persist for several months before death. Retention of nitrogen increases as the phthalein elimination drops; the uric acid being perhaps first affected, then the urea and finally the creatinin. This is the most important test of all in this group of cases and the reader is referred to the section on Diagnosis of Renal Insufficiency for a discussion of these tests and of the relation of nitrogen retention to uremia.

In this group of chronic nephritis also, borderline cases may occur in which there will be found evidences of impairment of water and salt elimination. Furthermore, confusion will often arise when an acute attack of nephritis or of circulatory failure is superadded to a chronic nephritis. Under such circumstances the results of functional tests may be altered for the worse and a more serious prognosis is apt to be given than the subsequent course of the case warrants. After the acute attack has subsided or the circulation is restored by digitalis therapy the functional tests will often markedly improve and return to their former level.

Basal metabolism is said to be lowered in the edematous cases.

Acidosis is more apt to occur in the non-edematous type; its recognition is important as an indication for treatment rather than as a help in diagnosis.

COURSE, COMPLICATIONS AND PROGNOSIS.

Either form of chronic nephritis may drag on for many years, but when edema is a marked symptom the course tends to be shortened by the development of serious complications. Some cases of the edematous type do recover after several years duration, but this result is unfortunately less common than a steady downward course to a fatal issue within three or four years of the onset of symptoms. Especially bad is the prognosis in patients no longer young. The prognosis must be cautiously made in such cases with edema, for the unexpected often occurs; very rarely the apparently hopeless case may suddenly and without explanation develop a diuresis, get rid of all dropsy and return at least temporarily to health. On the other hand, it is common for a patient who is apparently doing well to develop pneumonia, pulmonary edema, myocardial failure, pericarditis, pleurisy, peritonitis or some other of the intercurrent infections to which such individuals are liable, and rapidly succumb. Tests of function will give no warning of the likelihood of these complications and one can do little more than generalize that as a rule the poorer the renal function as indicated by the functional tests the more serious is the prognosis. A long duration of the disease without improvement, a marked degree of dropsy, the evidences in the urine of continued degeneration of renal parenchyma, and poor response to tests of the kidney ability to excrete water and salt are all points tending to suggest a bad prognosis. The outlook is also unfavorable if such an edematous case commences to show an elevation of blood urea nitrogen and other features more characteristic of the non-edematous variety, although such a shift in picture is compatible with many years of life.

Chronic nephritis without edema is a far slower disease than the variety just discussed. Its duration may reach twenty or more years and in the end one may be in doubt as to whether the kidney trouble has to any great extent hastened the death of the individual. The course may be very gradual, with few or no appreciable ups and downs, or on the other hand, there may occur minor exacerbations, perhaps with slight pyrexia. These are thought by some to be in fact

slight attacks of an acute nephritic nature superimposed on the chronic disease. More marked acute nephritis may appear in a chronic nephritic and forms a serious complication which not infrequently results fatally. The picture is often that of a simple acute nephritis and the chronic process is overshadowed and frequently not recognized.

Many of the other complications usually mentioned would seem to be referable either to the changes in the cardiovascular system or to the uremic toxemia. Cardiac failure due to myocardial insufficiency is perhaps the most important in this group. Its development may rapidly change the clinical picture, and by congestion it seriously embarrasses the kidneys and increases the likelihood of uremia. The fatal outcome of chronic nephritis is often determined by myocardial failure and lowered blood-pressure. On the other hand, cerebral hemorrhage is a complication resulting from the increased pressure and the arterial degeneration. It is a constant menace in patients whose pressure is very high and it must be considered in the prognosis of patients with high arterial tension and especially in those who have been found to have ophthalmoscopic evidence of sclerosis of the retinal vessels and retinal hemorrhages. Hemorrhages from other sources, such as nose bleed and hematuria, only occasionally become serious.

This type of chronic nephritis also presents the tendency to serous surface involvement, pericarditis being apparently the most frequent, and being characterized by the variability of its physical signs from day to day. Often, however, a pleurisy or pericarditis may repeatedly occur without altering the course of the disease. A similar tendency to intercurrent infections, such as pneumonia and erysipelas, is also present.

Uremia can scarcely be considered a true complication, but some of its manifestations have been thus designated, for example, stomatitis and gastro-enteritis.

Death usually results from uremia, apoplexy or intercurrent infection, and this latter often hastens the onset of a uremia, perhaps by a depressing action on the already burdened myocardium. Prognosis must always be difficult in the midst of so many dangers. Poor myocardial tone, ex-

treme and increasing hypertension, retinal or other hemor-
rhages, a high and rising blood urea nitrogen, an increase
in the blood creatinin, very low phenolsulphonephthalein
elimination, marked fixation of specific gravity, all of these
argue for a poor prognosis. Albuminuric retinitis is a sign
of grave prognostic import. The urine gives us little aid, and
the functional tests must be frequently repeated to give the
greatest assistance. A steady lessening of function is seri-
ous, but a constant though low level may be consistent with
years of life if the individual's life can be properly regulated.
Prognosis will somewhat depend upon the degree of co-
öperation in treatment which can be hoped for. When a
grave prognosis is to be based on the results of functional
tests, one wants to be sure that neither cardiac insufficiency
nor an acute exacerbation of nephritis are temporarily de-
pressing renal function. Only with repeated tests and
markedly abnormal results can a grave prognosis be given
with certainty and even then the probable duration of life
cannot be accurately prophesied. Uremia, when it develops,
at once makes the prognosis extremely grave and this is true
in a measure of the early preuremic manifestations.

DIFFERENTIAL DIAGNOSIS.

Typical examples of the two types of chronic nephritis can
hardly be confused, but atypical cases occur which present
certain aspects of each variety. These intermediate cases
cannot always be placed under either heading and have to
be diagnosed as mixed forms. As a rule, however, one or
other clinical picture dominates and the case is accordingly
designated.

In the case of chronic nephritis with edema the diagnosis
is usually easy if the history is known. The urine gives evi-
dence of a severe renal disturbance and the history tells us
of the duration of the case. By the history of preceding
dropsy one can sometimes recognize the case which has
progressed towards the stage of contracted kidney.

Circulatory failure may bring about edema by passive
congestion of the kidneys, albumin and casts in the urine.
The differential diagnosis should, however, be easy; the

edema does not have the characteristics of renal dropsy, the albumin is less in amount, the casts fewer and the beneficial results of digitalis therapy are much more marked. Far more difficult, and often impossible, is it to properly separate the effects of chronic nephritis and of passive congestion when both are present together. Only time and treatment will then tell.

Amyloid disease of the kidney may closely simulate chronic nephritis with edema, but in amyloid disease some cause such as chronic suppuration or ulcerative tuberculosis will have been active and evidence of amyloid disease in other organs will usually be present. The urinary picture may be very similar, but in amyloid disease there is seldom very marked anasarca and little accumulation of nitrogen in the blood; the phthalein elimination will be good.

Chronic nephritis without edema may be mistakenly diagnosed on the basis of albuminuria. Albumin in the urine, even in an overworked, somewhat sclerotic middle-aged individual, does not of necessity mean chronic nephritis. It is only necessary to name a few alternative possibilities: hematuria, "physiologic" albuminuria, chronic passive congestion, prostatitis, calculus, etc. Passive congestion gives a specific gravity higher than is usual in chronic nephritis of this type, and other evidences of circulatory inadequacy should be discovered by careful examination. It must be remembered, however, that congestion may markedly influence a number of the tests of renal function.

Hypertension and arteriosclerosis may occasionally be misdiagnosed as chronic nephritis but the error, if it is one, is in the right direction. It is certainly wise to be suspicious of the kidneys if the blood-pressure continues high, and to keep an eye on the kidneys if arteriosclerosis is commencing to be evident in middle age.

Symptomatically diabetes insipidus may simulate chronic nephritis but this condition tends to appear in younger individuals, the specific gravity is usually much lower than in chronic nephritis and the cardiovascular changes characteristic of nephritis are seldom if ever present. In cystic disease of the kidneys, evidences of chronic nephritis may overshadow the primary condition; the nephritis, however, is

present and the diagnosis so far as it goes is correct. Uremia, when it occurs, must be differentiated from other causes of convulsions and unconsciousness.

The diagnosis of chronic nephritis without edema, to be of the greatest assistance, must be made at a time before marked changes in the heart have appeared and before functional tests have been greatly disturbed. At this early stage the only evidence may be a slight albuminuria with a few casts, a tendency to fixation of specific gravity, hypertension and changes in the retinal vessels. Occasionally albuminuric retinitis may develop early. The discovery of any of these features in a middle aged individual justifies a positive diagnosis of chronic nephritis unless another explanation is forthcoming. Furthermore, these evidences should be diligently searched for on every occasion.

TREATMENT.

Prevention is of the utmost importance. Part of the justification of a work on diseases of middle age lies in the emphasis which such a work places on the importance of the early recognition and prevention of the many chronic conditions which commence in middle age, and which in a large measure determine the span of our life. Efforts at prevention do not immediately make their results evident, and it will be only by thorough, conscientious attention to this aspect of the situation that beneficial results will be obtained. But our hopes for the future lie in this direction. Prophylaxis should include extreme care in the treatment of those infections which are known to be frequently complicated by acute nephritis and convalescence must not be hurried. Acute tonsillitis must be treated more carefully and it must not be thought of as only a local matter; the scarlet fever patient must be protected from cold and must receive sufficient water. Every acute infection should be considered as a possible excitant of nephritis, and rest in bed, limited diet and plenty of fluid should be insisted upon until the infection is well over. And finally a routine urine analysis might be made before the patient is allowed to return to active life.

Chronic foci of infection should be eradicated before any symptoms of systemic trouble appear. Abscesses about the

roots of teeth and chronically diseased tonsils deserve atten-
tion of themselves without waiting to see if any secondary
damage will be done. It is true that definite proof is lacking
of the causal relation of focal infections to nephritis but there
is much evidence to suggest it. Chronic intestinal troubles
should also receive attention, and infections of the lower
urinary passages should not be allowed to run on untreated.
Obstruction of the lower urinary passages should, if possible,
be relieved.

Pregnancy is the starting point of many cases of chronic
nephritis and repeated urinary examination should be made,
both during the pregnancy and the puerperium. Avoidance
of pregnancy had best be advised if nephritis is present, and
also if any degree of nephritis occurred during a previous
pregnancy. It is quite possible that the group of chronic
nephritis arising in pregnancy will prove to be the most
readily preventable by proper medical supervision during the
pregnancy.

Dietary peculiarities, such as an excessive protein or salt
intake, should be warned against and an adequate fluid in-
take insisted upon. The modern increase in the use of chemi-
cals and synthetic substances may perhaps be sowing the
seed of a serious harvest of renal mischief.

Another aspect of this question of the prevention of nephri-
tis concerns itself with the prompt and proper treatment of
such conditions as diabetes mellitus, gout, lead poisoning and
syphilis, in each of which the development of nephritis is far
from uncommon.

Treatment to Stay the Progress of Chronic Nephritis. Albu-
minuria, even in middle age, does not always mean serious
nephritis and its discovery may be beneficial, as Osler pointed
out, for the patient may be led to regulate his life and habits
and to improve his general hygiene. The discovery of any
evidences of chronic nephritis should result in the instituting
of all measures to improve the patient's general condition, to
avoid any further damage to the kidney, and to relieve it of
as much work as is reasonably possible.

In attempting to carry out these steps in a patient who is
not acutely ill, common sense is the prime requisite. No two
individuals can be moulded alike; habits, tastes and idiosyn-

crasies must be considered. Harm may come from a too unbending dogmatism in treatment. The active business man may be more harmed by fretting in enforced leisure than by a few hours daily at his desk. Worry and anxiety are to be avoided, if possible.

Any foci of infection, convicted after an honest trial and before a capable judge, should be removed if the patient's condition will permit. Fitz has recently reported some suggestive results from tonsillectomy. Any diseased conditions should receive appropriate treatment. In addition the avoidance of acute respiratory infections should be emphasized; this may be accomplished to some degree by spending the winter months in a warm climate. Sufficient rest must be insisted on and in all respects the best guide is the old saying, "Moderation in all things." A little exercise is desirable; a weekly Turkish bath or sweat, and a daily warm bath are desirable. The bowels should be kept freely open, but diarrhea should not be encouraged.

Diet is probably of less importance than has been commonly attributed to it. A reasonable balanced diet, with somewhat less than the usual content of protein and of salt, is as far as one can honestly go. Von Noorden suggests 94 grams of protein as the maximum figure and bases his conclusion on the fact that the chronic nephritic can easily excrete the 15 grams of nitrogen derived from this amount of protein, but above this figure has difficulty. Alcohol and strong seasoning may perhaps be properly forbidden and any tendency to excess in diet should be checked. The caloric intake must be sufficient and the protein requirement met, but more than this is probably harmful. Weight should not be allowed to increase above the normal for the patient in health. Fluids will be regulated, as a rule, according to the type of case; where there is no tendency to edema it is probably better to give at least two quarts per diem.

All of these directions concerning diet are indefinite and this must be so for three reasons: In the first place, our knowledge of this subject is not extensive; secondly, the patient will not persist with any one diet for the long period over which this disease extends; and thirdly, as a rule there will be present other indications for dietary regulations, such

as dropsy or a tendency to uremia. The question of diet in such conditions has already been discussed. If there is no special indication the protein may be limited to between 60 and 80 grams, the salt to about 5 grams; fluids to 2000 cubic centimeters, and the total intake to about 1800 to 2000 calories.

Medicines find no place in the treatment of chronic nephritis unless perhaps iron is indicated for anemia, or a cathartic is required. Diuretics are certainly not to be employed. Mention should perhaps be made of the value of antiluetic treatment in the occasional case of chronic nephritis and syphilis. Even though one is not sure that the kidney damage is due directly to the syphilitic infection which is present, yet antiluetic treatment should be instituted cautiously, with the patient under constant observation, for at times such therapy only aggravates the nephritis.

When dropsy, uremia or cardiovascular manifestations complicate the picture, more active therapeutic measures are often indicated. These need not be repeated here, as they will be found in the section on Treatment of Renal Insufficiency, under the respective headings.

NON-TUBERCULOUS INFECTIONS OF THE KIDNEYS.

This group of conditions occupies a borderline position between the domains of the internist and the urologist; the individual conditions are of importance to both the general physician and to the urological specialist. Certain forms of renal infection seem to belong more properly to the urologist and will be found fully described in another article; others must be mentioned by both.

ETIOLOGY.

Especially the source and cause of infections of the kidneys are of interest to the internist who has to make the primary diagnosis, and who can attempt to prevent the occurrence of renal infections in the course of other diseases.

Formerly the theory of blood-borne or hematogenous infection was advanced for only one or two forms of renal

infection, but more recently this route has been more and more accepted at the expense of the older belief in so-called ascending infection. By this latter term is meant the spread of infection either by the urine, mucous membrane or peri-ureteral lymphatics, from the bladder to the kidney. This method of renal infection is nowadays only considered likely when normal conditions are altered either by an obstruction of the ureter as by calculus, or by a dilatation of the opening of the ureter into the bladder, as occurs for example in cases of obstruction at or below the vesical outlet. With these exceptions all renal infections are now believed to reach the kidney via the blood, or in rare instances by direct extension of infection from neighboring structures to the kidney.

A variety of bacteria may cause mischief in the kidney; among the most frequent are colon bacilli, staphylococci and streptococci, and various combinations of colon bacilli and the pyogenic cocci. Other organisms occur less frequently, for example, typhoid and paratyphoid bacilli. Even more varied are the predisposing causes of renal infection; under this heading are included all those factors leading to the entrance of bacteria into the blood stream, and secondly those factors which determine the localization of circulating bacteria in one or both kidneys. Concerning the conditions under which bacteriemia occurs little need be said here; it is undoubtedly true that bacteriemia is far more common than was formerly believed, certainly the modern conception of endocardial infections and of renal infections is based on this premise.

Bacteriemia may occur incident to such a trifling local infection as a felon or a furuncle, or it may occur during a tonsillitis or enteritis, or perhaps even from constipation, without there being any other than what we recognize as local symptoms and with apparently complete disappearance of the blood infection within a few days. In other instances a marked lowering of general resistance appears to be followed by the entrance of bacteria into the blood from some focus of infection. More obvious causes of bacteriemia are certain infectious fevers, such as typhoid and pneumonia, puerperal sepsis and the spread of infection from infected wounds, etc. During the stage of bacteriemia of any one of

these conditions, a renal or perirenal localization of infection may occur and suppuration develop.

The kidneys receive a share of all circulating bacteria and in many instances the bacteria are passed through the kidneys into the urine without any damage to renal structure. In other instances gross infarcts may be produced by large bacterial masses, or multiple minute infarctions or abscesses by smaller emboli. Sometimes the lesions in the kidneys are merely a part of a general septic process, but again the kidney alone seems to suffer. The factors which determine the localization of infection in or about the kidney may reside, as some believe, in a selective affinity possessed by the organism for the urinary tract. Others, however, emphasize the importance of local conditions in the kidney: thus, for example, a kinking of the ureter due to movability of the kidney, or pressure on the right ureter by the pregnant uterus, are considered sufficient to cause organisms, which otherwise would have been excreted harmlessly through the kidney, to initiate local trouble. Local factors such as hydronephrosis and renal stone also make the organ liable to infection.

Ascending infection from the bladder is rendered likely or at least possible by such lesions as ureteral stone or stricture, prostatic hypertrophy, urethral stricture, and even by retention of urine from functional causes. These same conditions, it must however be admitted, might also favor the localization in the kidney or near it of blood-borne infection.

The character of lesion produced depends in part on the nature of the infecting bacteria. Bacterial emboli will usually affect both kidneys equally and the virulent organisms of a severe sepsis will produce multiple abscesses in each kidney. On the other hand, an infection may find suitable conditions for localization in only one kidney and so a unilateral process may, and often does, occur. When the infecting organism belongs to the pyogenic group the resulting renal mischief is apt to be in the nature of abscesses either in the perinephric tissues, immediately under the capsule, or in the renal cortex. Some have employed the term "acute interstitial suppurative nephritis" to describe such a process in which pyogenic cocci are causing multiple minute abscesses in the kidney, a process

which may go on to the production of diffuse suppuration and complete destruction of the kidney.

On the other hand the members of the colon-typhoid group are more apt to produce infections of the pelvis of the kidney and by direct extension from the pelvis, some involvement of the kidney itself. The term pyelonephritis indicates the occurrence of this renal involvement and this term should probably be often substituted for simple pyelitis. Not only may the colon-typhoid group reach the kidney via the blood stream but it is the members of this group which are frequently the infecting agents in cases in which ascending infection has apparently taken place. At the upper limits of middle age prostatic hypertrophy becomes a prevalent cause of such ascending infection of the kidney.

SUPPURATIVE NEPHRITIS.

Under this heading can be placed both the blood-borne infection of the kidney and the renal involvement which occurs from an extension of a pyelitis. The two are often confused, but in typical cases there are some differences. On the one hand, the deposit of virulent organisms in the kidney by the blood stream results either in a gross infarct if the bacterial embolus is large enough, or more usually in a rapid thrombosis and necrosis of a glomerular tuft with secondary abscess formation. These abscesses are scattered through the cortex and may fuse to form larger collections, or may rupture out under the capsule. Similar abscesses in the medulla may also be present. When the process has extended up from the renal pelvis the term pyelonephritis is descriptive and the brunt of the infection falls on the medullary portion of the organ. Striæ of upward extending infection may be seen in the gross specimen and the microscope will reveal polynuclear leucocytes infiltrating between the tubules. In both varieties of renal infection there is an associated diffuse nephritis; the organ is enlarged, firm and markedly hyperemic with individual abscesses scattered here and there. Later when suppuration has become diffuse the organ may be softened and extensively destroyed. If recovery takes place, scar tissue will replace the areas of greatest disintegra-

tion, and more or less evidence of the associated nephritis will remain.

Symptomatically there is an enormous variance between individual cases depending in part upon the nature of the underlying cause and in part upon the severity and distribution of the renal infection. In one instance the renal involvement may be entirely overshadowed by the general infection or pyemia from which the patient is suffering, in another the picture may closely resemble a fulminant appendicitis, and in fact unilateral right sided cases have more than once been operated on under this mistaken diagnosis. In still other instances the renal involvement is lost sight of because of a lower urinary tract infection; this is especially true in the cases of supposedly ascending infection. For example, a patient, E. M., with typhoid fever developed an extremely severe pseudomembranous cystitis during convalescence; the urine was filled with pus and blood. There were no local renal symptoms and it was impossible to do more than speculate as to the presence of a pyelonephritis. Cystoscopy revealed an almost gangrenous bladder; the ureteral orifices were hidden by the extensive shaggy necrotic membrane. At autopsy the left kidney was uninvolved while the right ureter and renal pelvis exhibited the same changes as the bladder; the tips of the pyramids were black and much of the medulla was disintegrating.

Three main groups of symptoms may be recognized: those due to the generalized infection, the local symptoms of the renal disease, and the manifestations of such renal insufficiency as may appear. Chills and irregular fever, sweating, headache, delirium, vomiting and general aching pains are among the evidences of the infection, but these are by no means characteristic. Leucocytosis is usually present and an increased percentage of polymorphonuclear neutrophiles, but the change is not always proportionate to the severity of the process. Renal pain, strangury, and increased frequency of urination are renal symptoms not infrequently complained of, and on examination a deep tenderness may be elicited and the swollen, tender kidney may occasionally be palpated. Edema of the skin and superficial swelling

seldom occur if the infectious process is limited to the kidney itself.

The urine quite constantly shows pus when the renal pelvis is involved or after abscesses have developed in the kidney and ruptured into the tubules or pelvis. This sudden appearance of pus or an increase in a previous pyuria, is suggestive of the rupture of an abscess. In the early stages of hematogenous suppurative nephritis there may be little or no pyuria, but its appearance is usually not long delayed. Hematuria is quite constantly present but usually not in gross amounts. Often there are so few localizing symptoms that it is only by catheter and cystoscope that it can be determined whether one or both kidneys are involved. During an acute attack one kidney often shows less involvement than the other.

Sooner or later in many instances symptoms of renal insufficiency arise; prodromal manifestations of uremia are not uncommon and true uremia may abruptly terminate such a case of suppurative nephritis, though to what extent the renal insufficiency is to be blamed on the suppurative lesions directly rather than on the associated acute diffuse nephritis is uncertain. Warning is usually given by a rising blood urea nitrogen and by a markedly diminished elimination of 'phthalein. Oliguria and edema are not infrequently present, but hypertension only gradually appears in the protracted cases.

Diagnosis is difficult and hematogenous infection of the kidneys is often mistaken for influenza, typhoid fever, appendicitis, pleurisy, pneumonia, lumbago or cholecystitis, according to the prominence of this or that aspect of the case. The interval which may elapse between the primary infection, which may have been a tonsillitis or furuncle, and the development of renal symptoms is so long that in many instances the original trouble is over and forgotten and is lost sight of in making the diagnosis. Of the various symptoms pain is probably the most reliable guide; it is far more constant than is renal colic and is often readily localized to the kidney area. A sensitive point near the attachment of the eleventh and twelfth ribs to the spine is not infrequent. The urine cannot always be relied upon to show anything of diagnostic help except in the cases with pyelitis or with

multiple abscesses.   It must also be remembered that not so very rarely the renal infection is only one localization of the bacteriemia; cases of coincident appendicitis or cholecystitis are on record, for example.

Prognostically the cases vary widely according to the virulence of the organism and other factors involved.   Some run a rapid fatal course, others recover spontaneously with more or less permanent damage to the kidneys.   In some, prompt treatment is life-saving.

Treatment must be directed at the cause, whether this be in the nature of an infectious focus or a lower urinary tract obstruction, such as prostatic hypertrophy, or both.   Measures directed at assisting the kidney to perform its functions may be indicated and efforts should be made to promote diuresis, diaphoresis and catharsis.   Operation may be required either to relieve tension and permit drainage by decapsulation or nephrotomy, or in the rarer instance of unilateral renal suppuration nephrectomy may be justified.

PYELITIS.

Much of what has been said above applies with equal truth to pyelitis, and this condition will be more fully discussed in another article.   The same etiological factors are responsible for pyelitis as for renal suppuration with, however, a greater frequency of "ascending infections."   Its symptomatology merges with that of suppurative nephritis of the pyelonephritic type; it is, on the whole, a less severe disease and there is less tendency to renal insufficiency.   It is not out of place, however, to remind ourselves that pyelitis usually arises from a blood-borne infection and may, and usually if not always, is associated with some involvement of the kidney.   As a rule this renal involvement is not sufficient to impair the kidneys' functional capacity, but when the process has persisted for some time, as for example when there is chronic back pressure from prostatic hypertrophy, then renal insufficiency often develops.   In such individuals the kidneys have often already been somewhat impaired by a chronic nephritis or by arterial disease, and the added elements of back pressure and infection are sufficient to seriously interfere with renal function.   Fortunately, the relief of the

obstruction, in the vast majority of instances, results in an improvement in the functional capacity of the kidney.

PERINEPHRIC ABSCESS.

In middle age, infection of the perirenal tissues with abscess formation is not of common occurrence. It is analogous in many respects to the hematogenous infections of the kidney proper and in fact a perinephric abscess may be caused by the rupture of a small infective infarct or cortical abscess through the renal capsule into the surrounding fatty tissues. or by direct extension of infection from a pyonephrosis. On the other hand, bacteria may reach the perirenal space directly by the blood stream or by extension from the pelvis, ureter, bowel or spine. The same factors predispose to perirenal abscess as are active in the production of suppurative processes in the kidney; trauma is, however, of greater importance as determining the localization of infection in this area, and statistics seem to show that the staphylococcus is more often the offending organism.

In one type of case the onset picture will be the same as that described under hematogenous suppurative nephritis; an example of the other variety, in which extension from the kidney occurs, is worth quoting in contrast: A woman of fifty-seven years of age had had a vague abdominal pain for five years; for one year a definite pain in the left side. More recently attacks of acute left-sided pain had developed and also vomiting and some edema of the legs; the urine had been bloody. On admission the woman was in very poor condition, a large mass could be palpated in the left upper abdomen, the urine contained pus and bacteria, the blood showed marked secondary anemia and a leucocytosis of 17,000. Roentgenograms showed a large left kidney shadow; cystoscopic examination revealed a chronic cystitis, and pus gushing from the left ureter; indigo carmine appeared from both ureters in ten minutes. Operation revealed an extensive abscess cavity which had already infiltrated the body wall, the kidney could not be palpated. The original condition, in all probability, was a chronic pyonephrosis with extension to the perirenal tissues and abscess formation.

Once the loose retroperitoneal tissues and the fatty cap-sule of the kidney become infected the formation of an ab-scess rapidly progresses; as a rule it becomes of considerable size and the kidney is more or less enveloped in pus. Usually the major part of the abscess lies posteriorly to the kidney but an anterior localization is occasionally observed. From this position the pus tends to burrow in one or other direc-tion; it may evacuate itself into the bowel or lung, but more frequently it either passes down along the iliac fascia to Poupart's ligament or follows the psoas muscle to the groin. Usually the kidney, protected by its fibrous capsule, is not severely implicated, but occasionally the abscess either prim-arily or secondarily involves that organ and may even discharge into the urinary passages.

In the cases due to blood-borne infection the onset symp-toms are merely those of the primary trouble and few or no localizing symptoms appear. At first the abscess is not under tension because of the loose nature of the perirenal tissues; eventually, however, tenderness develops and a ten-der swelling can often be palpated on the affected side. This swelling does not move with respiration but the superficial tissues over it may appear reddened and even edematous. Muscular resistance will be noticeable both anteriorly and posteriorly and the whole lumbar region on the affected side may bulge; this fullness is best seen with the patient in the sitting position. Spontaneous pain is sometimes severe, some-times absent; it may radiate down to the thigh and is often aggravated by extension of the leg, as in walking. Irritation of the psoas muscle tends to the keeping of the leg in a flexed position.

In addition to the local symptoms the general manifesta-tions of infection occur; chills and fever of an irregular character are present and there is usually a leucocytosis. In most instances the kidney is so little involved that the urine shows no more than it would were the same degree of in-fection present in a distant part of the body, and no inter-ference with renal function occurs. Less frequently leuco-cytes and erythrocytes are to be found in the urine, and if the abscess actually enters the kidney, pus may appear. Rupture of the abscess into the renal pelvis would be fol-

lowed by the continued presence of considerable amounts of pus in the urine.

It is often said that the diagnosis is usually easy, and this is true in outspoken cases; on the other hand, as Kidd says: "No cases lie longer undiagnosed in medical wards than these." The absence of urinary findings other than a little albumin is frequently incorrectly advanced as an argument against this diagnosis, and the failure of the examiner carefully to examine the patient's back is another cause of error. On the right side the condition is often mistaken for gall-bladder or appendix trouble, while the fixation of the corresponding leaf of the diaphragm may lead to the mistaken diagnosis of a basal lung infection. If the abscess is on the left side a fluoroscopic examination may reveal the characteristic sign described by Fussell and Pancoast, which consists of the occurrence, on shaking the patient, of a visible wave in the diaphragm above the abscess, due to a commotion in the liquid contents. A tuberculous abscess from spinal caries may reach the perinephric space and produce a very similar disease picture although the evidences of acute infection are apt to be less marked.

Prognosis is good if the primary infection is overcome and if the kidney is not extensively involved. Surgery is the only cure for a perinephric abscess and should be resorted to as soon as the diagnosis is made. Not infrequently the exact nature and extent of infection in the kidney region will only be determined at operation and one must be prepared to find in some cases that drainage of the abscess must be accompanied by removal of a hopelessly diseased kidney.

Tuberculosis of the kidney, pyonephrosis, and other aspects of pyelitis, etc., are discussed in the section on Diseases of the Urinary Passages.

MISCELLANEOUS.

AMYLOID DISEASE OF THE KIDNEY.

That amyloid disease is no longer of frequent occurrence is a result of advances in the treatment of the chronic conditions which cause this widespread process. Prolonged suppuration is by far its commonest precursor and it seems to

matter little whether the suppuration occurs in a chronic osteomyelitis, a long-standing empyema or in pulmonary cavitation from tuberculosis or bronchiectasis. Tertiary syphilis, gout, leukemia, and cachectic states in general, are also often mentioned as etiological factors, but are of much less importance. How and why prolonged suppuration results in amyloid infiltration of the kidneys, liver, spleen, etc., is not known, and experimental research has given contradictory results. Young persons are more often affected than the elderly, but no small percentage of cases occur in middle life.

The kidney is the organ most frequently involved; it becomes enlarged, sometimes quite markedly, and is firm and pale. Amyloid material is deposited both in the walls of the smaller blood-vessels, in the glomerular tufts, and under the epithelium of the tubules. Destruction of glomeruli follows the infiltration of the tufts, and fatty degeneration of the epithelial cells eventually results from interference with capillary circulation and from pressure. The involved glomeruli may appear as homogeneous hyaline-like bodies; the tubules show fatty degeneration and their lumina contain casts.

In some instances amyloid disease of the kidneys is combined with nephritis; this seldom occurs in the markedly chronic forms of nephritis with contracted kidneys, but rather in the subacute or early chronic forms in which edema is usually present during life and the large white kidney is apt to be found. Confusion of this type of nephritis with amyloid disease of the kidneys is easy and the two are not so infrequently present together.

Symptoms are absent in early or mild cases, nor will the urine show any change. When the process is more advanced the patient is apt to exhibit the signs and symptoms which characterize amyloid disease in general: cachexia, anemia, diarrhea, and enlargement of the liver and spleen. Evidences of renal involvement often make themselves evident even before these other manifestations become marked. Dropsy is usually the most important sign of renal insufficiency and may go on to anasarca with large serous cavity collections. There is apt to be little tendency to uremia in uncomplicated

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cases, although the picture may vary according to the extent
and localization of the damage to the kidney structures. This
fact and the frequency of a coëxisting nephritis explains why
some authors emphasize the fact that the urine is scanty,
others that it is profuse and of low specific gravity. The
latter is the more common condition in uncomplicated cases;
polyuria is frequent and albuminuria the rule. Indeed the
albuminuria is often much more marked than one usually
expects with a urine of low specific gravity from any other
cause.

There is nothing in the renal symptoms, in the urine or
in the manifestations of renal insufficiency, which speaks
especially for amyloid disease and the diagnosis will only be
suggested by the presence of a possible cause, such as spinal
caries, the discovery of smooth enlargement of the kidneys,
liver and spleen, or by the presence of a characteristic pallor,
cachexia, anemia and diarrhea. In those cases where amyloid
disease complicates another renal process as in nephritis the
diagnosis is even more difficult; occasionally a chronic pye-
litis may act as the cause for amyloid disease, which may in
turn affect the kidney.

Estimation of renal function is of importance from the
point of view of measuring renal insufficiency, but it gives
little help towards the diagnosis of amyloid disease. It is
true, however, that in this condition the 'phthalein elimina-
tion is little impaired until late and that there is little or no
tendency for the accumulation of nitrogen in the blood. As
true renal insufficiency develops, the function tests are cor-
respondingly altered.

Prognosis depends upon the primary condition and the
degree of renal damage; on the whole, it is unfavorable and
there is no reason to hope for a restitution of the kidney
to normal. However, the coincident nephritis may subside
somewhat in time and the patient improve more than might
at first be anticipated. Prompt treatment of chronic sup-
puration is of the greatest importance in prevention, and
careful watch should be kept on the kidneys during the
course of conditions tending to bring on amyloid disease.
Too long delay in amputating an infected foot, for example,
may be disastrous and the prompt recognition of urinary or

other changes might give warning in time. Once established the process must be treated by the same measures indicated for chronic nephritis and renal insufficiency from any cause.

CONGENITAL POLYCYSTIC DISEASE OF THE KIDNEY.

This is the most important congenital defect exhibited by the kidney, and it is of peculiar importance to the subject of this article, because although the condition is believed to be congenital and although it may be present at birth or in infancy, yet the majority of cases first produce symptoms and are recognized in the fifth or sixth decades of life.

A hereditary tendency is apparently of great importance not only in the cases occurring during infancy, but also in the adult instances of the disease. Wobus, for example, has reported the finding of this renal abnormality in four children of one mother, and the possibility of its having been present in still another of her children and in an aborted fetus. The hereditary influence in adults is well exemplified by F. C. Herrick's report of eight cases in one family: the father died at fifty-five years of age, mother at thirty-eight years, two aunts (mother's sisters) at forty-six and fifty-two years, one cousin at forty-five years, one brother at thirty-five years, one sister at thirty-eight years, and the patient himself died aged forty-eight years. Of these eight cases the diagnosis of congenital polycystic kidneys was proved at autopsy in six, and was the diagnosis made by excellent medical authority in the other two.

The origin of the condition has been variously explained and it is quite possible that a somewhat different process is responsible for the juvenile and adult cases. A developmental fault is usually blamed for the condition and the late appearance of symptoms is attributed to the slowly progressive nature of the process. Of the various theories perhaps the most attractive is that which explains the cysts as due to the accumulation of urine in tubules or glomeruli which lack, as a result of faulty development, any outlet. Both kidneys are usually, if not always, involved although one may show very much less cystic change than the other. In about one-fifth of all cases cysts have also been found in the liver. The

cystic kidney is almost always considerably enlarged even up to such an enormous size as to weigh two or three pounds. When markedly enlarged the shape of the kidney is apt to be entirely lost and the gross appearance resembles a bunch of grapes of various sizes and colors. Some of the individual cysts may reach a large size, others remain pea sized; some are thin walled and translucent with clear fluid contents; others contain blood or brownish material. On section of the organ it is seen to be honeycombed with the cysts, and often little or no renal parenchyma can be recognized; the pelvis is encroached on but is not involved. Microscopic examination, however, reveals in the septa between the cysts varying numbers of glomeruli and tubules which at times show nephritic changes. Sometimes there is evidence suggesting an effort at compensatory hyperplasia of the renal parenchyma, but this is as a rule abortive. One's chief thought after seeing such a kidney is one of amazement that it could have continued to function as long and as effectually as it did.

When the condition is present at birth the enormous size of the kidneys and the frequently associated ascites often lead to dystocia, and in the juvenile cases the bilateral renal enlargement usually makes the diagnosis easy. In adults, however, there may be no symptoms for many years, or only such vague symptoms as a slight dragging sensation on one or both sides, slight dizziness, or "indigestion." Eventually, however, one or both of the organs may reach such a size as to attract the patient's attention or to produce marked local symptoms of discomfort or even pain. In other instances occasional hematuria is the first symptom, and with each period of bleeding there may be colicky renal pains suggesting renal calculus. In still other instances the primary evidence of the disease appears in the form of renal insufficiency usually of a nature similar to that seen with true chronic diffuse nephritis. For example, a woman of thirty-six years of age had a little edema of the face and some headache; a month later a sudden convulsion; she was admitted to the hospital shortly afterward and large characteristic masses were found in the right and left kidney regions. The urine was of low specific gravity, contained a cloud of al-

bumin and a few hyalin casts; hematuria was intermittent. Later the diagnosis of bilateral polycystic kidneys was confirmed.

On physical examination only one cystic mass is, in many instances, palpable and this may confuse the picture; on the left side the mass may be mistaken for an enlarged spleen, and a division between two cysts for one of the splenic notches. The mass does not always move with respiration and can be displaced to a variable degree by pressure; often the irregular surface can be recognized and even individual cysts identified. In addition the physical examination may reveal all the ocular, cardiac and arterial evidences which characterize chronic nephritis. Hypertension is frequently present and cardiac hypertrophy also. In McKinlay's report a male of thirty years of age had a systolic pressure of two hundred and thirty and died of cerebral hemorrhage. The kidneys showed polycystic disease; the heart was hypertrophied and the arteries were sclerosed; there was a syphilitic mesarteritis and the spinal fluid gave a strongly positive complement fixation test for syphilis.

Urine examination may reveal nothing abnormal; a large amount of urine of low specific gravity with little or no albumin and few casts is probably the most characteristic finding unless hematuria occurs. Hematuria, when it appears, is fairly profuse but of short duration. Functional tests will give results compatible with the degree of undamaged renal parenchyma which is still active; eventually when renal insufficiency has appeared the tests will be correspondingly altered. It has been claimed that 'phthalein elimination is early decreased, even before other evidences of renal insufficiency appear. As uremia threatens the usual accumulation of nitrogenous metabolites will be found in the blood.

Diagnosis will depend upon the palpation of one or both of the greatly enlarged, irregular and cystic kidneys, upon the occurrence of intermittent hematuria, or the appearance of renal insufficiency. Probably the majority of correct diagnoses have been based on the recognition by palpation of the enlarged irregular kidneys. Hematuria will at best only lead to the diagnosis through further study as, for example, by pyelographic roentgenograms; this method reveals the

encroachment on the renal pelvis by the cysts, but does not differentiate the condition from renal neoplasm. If neither hematuria nor a palpable mass is present the diagnosis is extremely difficult, and the evidence of renal insufficiency can scarcely be differentiated from that incident to chronic nephritis.

Prognosis is ultimately bad, although adults may live for at least five or six years after the recognition of the disease. Death usually results from renal insufficiency which may be precipitated, as in the patient mentioned on page 525, by some intercurrent infection. Uremia terminates the majority of cases; hematuria has occasionally been fatal. Treatment is of little avail although puncture of the cysts has been advised and is claimed to relieve pressure in the kidney and so improve renal function. Renal insufficiency should be guarded against and treated just as it would be in a case of chronic nephritis.

Solitary cysts of the kidney occur but seldom give symptoms; they may be large enough to be palpable and lead to confusion in diagnosis.

Echinococcus and dermoid cysts of the kidney are rare, and need little further mention.

CIRCULATORY DISTURBANCES.

Kidney function is dependent upon the flow through the organ of an adequate amount of blood at a satisfactorily maintained pressure. Glomerular activity especially, seems to vary with changes in the blood-pressure and no marked decrease in pressure can exist for any length of time without, for the time being at least, interfering with renal function. If the blood-pressure falls below a certain point all secretion of urine ceases and degenerative changes in the renal epithelium will promptly commence. Much the same result occurs if the blood itself is extremely anemic. *Renal ischemia* or anemia is of no great clinical importance unless it becomes very marked; minor grades give no symptoms other than perhaps a mild albuminuria, but when more severe ischemia develops the amount of urine decreases and the albuminuria increases. Total anuria may occur from both general and local causes of renal ischemia, such as, for

example, embolism of the renal artery or spasmodic constriction of the renal vessels. This latter may be the explanation of certain cases of reflex anuria, as for example, after an operation on one kidney.

Active hyperemia of the kidneys is of interest chiefly as one element in the picture of acute nephritis, in which disease it is a constant feature and helps to explain the urinary findings and some of the subjective symptoms.

Passive congestion, especially when chronic, is of far greater importance than is often realized, and in middle aged patients it is a very frequent occurrence, usually from circulatory weakness of cardiac origin. Local conditions, such as pressure on the renal veins or thrombophlebitis of the renal vein, may cause passive congestion within the kidney, but much more commonly the general circulation is at fault; chronic cardiac and pulmonary diseases are responsible for the majority of cases. Early the kidney is enlarged and dark red in color; on cut section, blood-vessels and glomerular tufts are seen to be distended with blood. The cortex is swollen and individual glomeruli can often be recognized as distinct dark red points. Later the interstitial connective tissue undergoes hyperplasia; round cell infiltration appears between the tubules and an increasing number of glomeruli become sclerosed. With the increasing fibrosis the surface of the organ becomes irregular and the capsule more or less adherent. Ultimately the size of the kidney may be diminished and the organ becomes very firm. At this stage the terms "cardiac kidney" and "cyanotic induration" are often applied. During the period of increasing fibrosis, degenerative processes often have also occurred in the epithelium of the tubules and glomeruli, and the picture of a chronic nephritis has been established. These features, however, are of variable degree, and long-standing passive congestion may bring about, in certain instances, amazingly little renal damage.

Subjective symptoms of the renal condition are usually lacking, or at least are lost sight of as a result of the primary trouble. There is apt to be a distinct reduction in the amount of urine, and the specimen will be found to be high colored, of high specific gravity, and to contain a moderate amount

of albumin, a few casts, and not rarely a few erythrocytes. As the later stages are reached or more true nephritis develops, the urinary picture will change accordingly.

Manifestations of renal insufficiency seldom occur; neither uremia nor renal edema tend to appear. Occasionally, however, uremia will terminate a very long-continued case. Tests of renal function are apt to be somewhat confusing, and must be very carefully performed to be of any value. The phenolsulphonephthalein elimination may be markedly reduced especially if the dye is injected intramuscularly; a higher figure will often be obtained following intravenous administration. Water and salt may be poorly eliminated, but urea will be promptly disposed of and there is no tendency for nitrogen to accumulate in the blood until at a late stage a true nephritis may dominate the situation. There is no loss of the power to secrete a concentrated urine, in fact the specific gravity tends to be fixed at a high level, perhaps 1.026 to 1.030.

Diagnostically a proper understanding of the effects of passive congestion on the kidneys is of great importance. When the presence of circulatory failure makes passive congestion probable, one must be very cautious in the interpreting of changes in the urine and in the tests of renal functional capacity. It is a common error to diagnose an acute nephritis when only passive congestion is present. In such instances the response to a diuretic such as caffein or theophyllin will often be a marked diuresis, which would be most unusual were a true nephritis present. Similarly digitalis therapy may cause a disappearance of most of the urinary changes, and a restoration of the functional tests to normal. On the other hand, one must be on the alert to recognize the presence of a true nephritis, and not persist in explaining away increasing urinary and functional test changes on the basis of a recognized chronic passive congestion. Even greater confusion may occur when passive congestion is superadded to a chronic nephritis. This is a common happening especially in those cases where the heart fails under a long-continued hypertension; in such cases the passive congestion of the kidney may not be recognized, for it often fails to produce its usual picture. The urine already shows albumin, the specific gravity is fixed at a low level by the nephritic

process and the tests of function have already been found abnormal. Even moderate passive congestion in such cases is a serious menace to the continued adequacy of the kidneys and should receive prompt treatment. In advanced cases it is often difficult to decide whether the heart or kidney process was the primary trouble with the other engrafted on it. Years ago Traube pointed out that when the passive congestion was secondary, the urine remained pale in color although of lessened quantity, and this rule is often of assistance.

Prognostically, passive congestion of the kidneys is of itself not serious unless there is also present a nephritic process. In uncomplicated cases the prognosis is that of the causative condition. Treatment is also that of the cause of the congestion and need not be discussed here. One measure does, however, require emphasis and that is the use of diuretic drugs. It is in these cases that the purin diuretics and especially caffein, exert their most favorable effects and apparently do no harm, which cannot be said of their use in nephritis. It is also in this group of cases that digitalis has gained its reputation as a diuretic, a reputation due to its effect on the circulation. If nephritis is also present the usual measures for its relief are indicated.

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Diabetes Mellitus

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Diabetes Mellitus.

FOREWORD.

DIABETES MELLITUS is a disorder of normal body metabolism in which there is a deficiency of the secretion of the islands of Langerhans of the pancreas. As a consequence of the disturbance of the internal secretion of the pancreas the normal utilization of carbohydrate is impaired, resulting, with normal kidneys, in glycosuria and an increase in the sugar content of the blood. Clinically in a well developed case of diabetes mellitus, which means usually an advanced case, the patient presents glycosuria, increased thirst, increased appetite, increased output of urine, fatigue, loss in strength and weight. It is not absolutely necessary that all or the majority of the aforesaid symptoms be present before the diagnosis of diabetes can be made. A patient presenting loss in weight or weakness as the only symptoms may upon the examination of the urine show a marked continuous glycosuria which if untreated goes on to a fully developed case with the classical symptoms. The presence of a majority or at least several of the typical symptoms suggesting diabetes in the absence of glycosuria warrants a determination of a blood sugar curve with the view of ascertaining if any alteration in sugar content of the blood is present. A failure of glycosuria to occur in the presence of hyperglycemia is due to inability of the kidneys to excrete sugar in the urine. The latter condition suggests disease or fatigue of the renal epithelium.

INCIDENCE.

It is most difficult to determine the true incidence of diabetes on account of the fact that in a number of people the disease goes undiscovered, death being due to one of its complications, or due to another disease independent of the diabetes. About one death out of every hundred in the United States is reported as being due to diabetes. Joslin[1] states that if dia-

(675)

betes should continue to increase in the next thirty years at
the same rate as statistics indicate it has increased in the past
thirty years it would soon rival tuberculosis as a cause of
death, and if this rate progressed for another generation dia-
betes would be responsible for almost all deaths in the world.
It is very apparent that this statistical information is built not
on actual increased occurrence but on actual increased recognition.
Joslin[1] estimates that in the United States today there are
more than one-half of a million of patients afflicted with dia-
betes mellitus. There is no doubt that there is an increase
in the frequency of diabetes throughout the entire world, but
not anywhere near the number which the statistics indicate.
In New York City the results of the examination of the urine
of 72,000 persons applying for life insurance shows that nearly
two per cent. had diabetes. Barringer,[2] who has compiled
these statistics, states that they relate to adults of the class
who make application for life insurance, and therefore this
percentage is not applicable to the entire population since the
disease is relatively infrequent in childhood as compared with
middle and old age. The explanation for the increase in the
frequency of diabetes probably can be attributed to a number
of causes. With the average increase of the duration of life,
throughout the world, as the result of better means of pre-
vention and treatment of disease, more people live to the
decades of life in which diabetes increases in incidence.
Modern civilization makes for more sedentary living and
an increase in total caloric intake of food, especially in sugar
consumption, all of which tend toward obesity. The great
stress and strain with the greatly increased responsibility,
which our present mode of living calls for, are contributing
factors of no little significance in the production of diabetics
in increasing numbers.

Before the world war the incidence of diabetes mellitus in
the central empires of Europe was reported as greater than the
incidence of diabetes in the United States. The greater in-
cidence occurred in Europe in spite of the fact that the per
capita consumption of sugar in the United States was nearly
twice as great. It must be remembered that the high total
caloric intake of food per day in the Europeans was largely de-
pendant upon beer drinking and to the character of their diet.

The incidence of diabetes mellitus in Berlin during the year 1913 was 409 as compared with 177 during the year 1918, according to Rosenfeld of Breslau.

ETIOLOGY.

Fundamentally the pancreas is at fault, that is the structures contained therein, known as the islands of Langerhans.

Diabetes is more commonly found to be present in men than in women in about the relation of three to two. There appears to be no particular reason to account for the greater frequency in men than women, except that some of the predisposing causes are present more frequently in men than in women, due to the stations in life they are called upon to fill. With the increasing responsibilities and the strenuous lives women are called upon to fill and to live, there is no doubt but that more accurately kept statistics will prove that under similar living conditions woman is no more immune from diabetes mellitus than is man.

Regarding the *age* at which the disease occurs, it has been discovered at any time during a long life beginning with a period shortly after birth. It is frequently difficult to determine how long the glycosuria existed before the disease was recognized, since it may, as a symptom in itself, attract no attention unless discovered accidentally. Probably the greatest number of cases are discovered between the ages of forty and fifty years, after they have existed with a glycosuria as a symptom for from two to four years. The incidence of pancreatitis follows closely the incidence of diabetes.

Considerable difference of opinion exists with regard to the importance of *heredity* and a positive family history of diabetes in connection with the etiology of this disease. Certainly a family history of diabetes mellitus is more often obtained in patients with this disease than in non-diabetics.

Joslin[1] states that in a series of 187 diabetic patients he found that twenty per cent. gave a history of the disease being hereditary, or a positive family history of diabetes mellitus. This figure is compared with but five per cent. giving a family history of diabetes mellitus in a series of five hundred consecutive non-diabetic patients. More thorough history taking and investigation into the family histories of our diabetic

patients will no doubt give us higher figures of the presence
of a positive history than is generally believed. This writer
also records a history furnished by a nurse who states that
her mother and her mother's eleven brothers and sisters all
died of diabetes, save one who also had the disease but is
still alive. Two of her aunts each had a child with diabetes.
All the patients were stout. He states that the family show-
ing the most marked diabetic heredity with which he person-
ally came in contact was a woman diabetic patient, age fifty-
four years, who had a brother who died of diabetes mellitus
and tuberculosis at the age of 48 years, a sister died of dia-
betic coma at the age of fifty-five years; a sister died of acute
indigestion at the age of fifty-eight years having had diabetes
mellitus for many years; a sister died of Bright's disease at the
age of fifty-six years having had diabetes for ten years; a
sister who is living has had acute indigestion and also dia-
betes; finally a brother died of la grippe at the age of sixty-
two years having had diabetes for a period of eight years. The
mother and the father, though dead, did not have diabetes. A
niece of the patient also has the disease. A number of strik-
ing examples very similar to Joslin's cases have been reported
and are most interesting because they raise the question:
What is the basis for this hereditary tendency, and what pro-
duces the pancreatic deficiency? Since pancreatitis is generally
acknowledged as the cause of diabetes mellitus, it is possible
that the hereditary tendency manifested may be due to the
presence of pancreatic tissue which is vulnerable to all the
infections, traumatisms and intoxications which ordinarily
have no effect on the normal pancreas. Cases of conjugal
diabetes have also been reported and those in favor of the
infectious theory claim this as evidence to support their
hypothesis. It is more than likely that these instances are
either accidental or rather coincidental and are due to the
similarity of habits as to diet, both in amount and character,
and to the lack of exercise, both of which occur in persons
with a tendency to obesity.

The influence of a hereditary history of diabetes upon the
course of the disease has been variously estimated by different
writers. It would appear that while the effect is by no means
uniform nevertheless the consensus of opinion is that hered-

ity exerts a favorable influence in that the disease is milder in character and often yields more readily to treatment. Very often diabetics who manifest the disease very early in life and in whom it runs a mild course, have a history of heredity.

Race. The text-books invariably state that the Hebrew race is more frequently affected than any other. The explanations for this frequency are, that as a race they present a tendency to be nervous and excitable, subsist on a relatively high carbohydrate diet, do not take very much exercise, and on the whole manifest a tendency to obesity. All these factors are predisposing causes of diabetes mellitus. Another explanation given by an observer was that the Hebrews who live in thickly populated centers usually seek promptly the best medical advice and attention, and in so doing have urine examinations made, as a result of which there is an increased recognition of the disease rather than an increased frequency.

Van Noorden in eleven years treated 1489 diabetic patients of which 31.5 per cent. were Hebrews. The course of the disease if well developed is probably not as favorable in Hebrews as other races in hospital experience, because of the difficulty in readjusting their diet or their inability to properly understand and to appreciate the importance of the instructions. Bread is a large increment of the diets of the Hebrews, as seen in the average dispensary patient and it is often difficult to get the patient to abstain from it. Here again it is probable that diabetes mellitus is of more frequent occurrence among the Hebrews as a class because of no inherent cause other than the tendencies they manifest in their mode of living, which if practiced by other races would develop as high a diabetic rate as exists among the Hebrews. The Japanese seem to enjoy a low incidence of diabetes. The negro diabetic is not uncommon in hospital practice. The lazy life they so often lead, their fondness for food, as observed in the case of cooks and domestics where it is easily obtained, and the high rate of syphilis among this race accounts for its occurrence in this race. Lemann's[3] analysis of the hospital records of 160, 044 patients with reference to the incidence of diabetes shows its presence in 0.86 per thousand negroes in comparison to 1.4 per thousand whites.

Obesity. By far the most common preëxisting abnormal condition found present in diabetics is obesity, either in the personal or in the family history. The average series of patients suffering from diabetes shows a history of obesity in from forty to fifty per cent. of cases. In a series of studies made by the writer on forty-two members of the police department of a large city, suffering from diabetes, forty-one of the forty-two patients gave a history of weighing more than 200 pounds at some time in their lives. This percentage would not be applicable to other walks of life, since the character of the duties of a policeman predisposes to obesity, and at the same time there are hundreds of policemen in this department who have been overweight for years and who are now past 45 years with no glycosuria.

Obesity is principally the result of one or two causes, that which has an etiological basis in disturbances of the endocrine system and the other which is due to excessive food consumption, high caloric intake and lack of exercise. When a person loses weight rapidly, or when a patient gains weight rapidly, sugar should be looked for. Gaining weight rapidly may follow the menopause, recovery from acute infections and the change from an active to a sedentary life. There are many more persons who are obese and yet non-diabetic than there are obese who develop diabetes. It must be assumed, therefore, that obesity in some way initiates an attack on vulnerable pancreatic tissue, which is due to the additional burden thrown upon or demand made upon the pancreas as the result of obesity.

Disturbances of Glands of Internal Secretion. It has been demonstrated that regardless of what other endocrines are diseased if diabetes mellitus is associated with an endocrine disorder the lesion responsible for the diabetes is in the pancreas.

Hyperthyroidism and disturbances of the hypophysis may be accompanied by a tendency to an increase in the blood sugar content and glycosuria and at times actual diabetes may result. That this diabetic condition is due to disturbances other than in the pancreas awaits verification. Glycosuria or a lowered carbohydrate tolerance occurs in endocrine disorders and may do so without an actual lesion of the pancreas. In endocrine disturbances it is highly probable that if diabetes is

present, a common cause may be responsible for both lesions. Holst,[4] in a thorough study of glycosuria and diabetes in exophthalmic goiter, states that the more severe cases of glycosuria in exophthalmic goiter are caused by a pancreatic affection. He further states that the plausible explanation of the cause of this pancreatic affection must be the fact that the inhibitory action which the thyroid gland normally exerts over the pancreas has increased on account of the thyroid gland hyperfunction in exophthalmic goiter.

Trauma. Injuries to the body, particularly head injuries, have caused glycosuria which may have been temporary in character or subsequently become diabetic in character. It is of course usually difficult to ascertain if, before the injury, the patient was in the possession of a vulnerable pancreas or diabetic tendency or whether an existing mild diabetes was aggravated. Probably the psychic shock accompanying the injury is the responsible factor, but it must be remembered that of the many severe injuries received, a very small percentage of the injured developed diabetes.

Nervous Disturbances. Almost all writers are agreed that the nervous element is a factor, either as provocative, or as a result of a cause responsible for the diabetes. It is not uncommon to find diabetes in the nervous, highstrung individual who undergoes great mental excitement and labors often under considerable anxiety. Assuming that a lesion in the pancreas is present in all diabetics it is difficult to see the connection that the nervous element would have in precipitating diabetes in a non-existent diabetic. The development of glycosuria under these conditions is a relatively common observation and recently in examining the urine of members of a freshman class in a medical school, who were undergoing a physical examination, five out of one hundred and fifty showed the presence of sugar, which reëxamined at intervals during the year were negative for sugar. The glycosurias and diabetics must not be jointly considered but separately, when evaluating the nervous element as a factor. The anxiety that patients have before an operation is at times accompanied by glycosuria and is at times unnecessarily disturbing to the surgeon, as the glycosuria promptly disappears after the operation has been performed and the fear removed.

Infections. The importance that infection plays in the de-
velopment of diabetes is still an unsettled question. It is a
well-known fact that the sugar tolerance is distinctly low-
ered in the presence of acute infection and recently a patient
of the writer suffering from diabetes, who had been on treat-
ment for more than a year and who had been sugar free dur-
ing this time, without any change of diet showed a positive
sugar test during an attack of severe rhinitis. This experience
is not uncommon in acute infections and is a striking demon-
stration of the effect that infection has on existing diabetes.
It seems that in a systemic infection, especially if repeated,
there is no reason why at times the pancreas should not be
definitely injured, resulting in pancreatic inefficiency sooner or
later in life, especially as this would help to explain many of
the cases in which it is difficult, without much speculation,
to establish the etiology. It was thought at one time that ty-
phoid fever in a diabetic had a favorable effect upon the dis-
ease, due to the observation that sugar usually disappeared
from the urine during the attack, to appear after the patient re-
covered. This disappearance can readily be accounted for by
the low caloric diet given in the typhoid fever treatment. The
part that acute inflammation plays in the causation of dia-
betes mellitus must also not be lost sight of. Focal infection of
the tonsils, teeth, sinuses and gastrointestinal tract, no doubt
play a rôle in the development of diabetes mellitus through
absorption of toxic material or bacteria, thereby giving rise
to inflammation of the pancreas. Diabetes mellitus has first
been noticed during or following attacks of influenza and acute
gastroenteritis. Recently a boy aged twelve who had seasonal
asthma with acute diabetes mellitus came under the observa-
tion of the writer.

Syphilis. Diabetes mellitus is no more common in syphili-
tics than in non-syphilitics, or is syphilis any more common in
diabetes than in non-diabetes. It is doubtful if much impor-
tance can be attached to syphilis as a predisposing factor. It
is possible for syphilis here, as in other parts of the body, to
produce interstitial inflammatory changes with accompanying
degenerative changes in the blood vessels, all of which will
impair pancreatic effciency but no special predilection has
been established for these changes in the pancreas.

Arteriosclerosis may effect the pancreas in very much the same manner as syphilis. Gout plays very little part in the etiology of diabetes except that the predisposing factors in gout may be responsible for the diabetes also, if the two conditions be co-existent.

Tumors of the pancreas, or pressure of tumors in the neighborhood of the pancreas, may provoke glycosuria or even actual diabetes. Interference with the proper drainage of the external secretion of the pancreas, by biliary infection and gall-stones, have been thought to be predisposing factors in production of diabetes. Their effect would be to develop a pancreatitis.

GLYCOSURIA.

Glycosuria is the term applied to the condition in which sugar is present in the urine as determined by the ordinary laboratory tests. It is not always dependent upon an increase in the blood sugar content, although the latter is usually increased when glycosuria is present. Glycosuria may be present for a considerable length of time, without any concomitant symptoms or without any impairment of health. There have been numerous forms of glycosuria described, the adjective used defining the condition. Intermittent glycosuria, alimentary glycosuria, non-diabetic glycosuria, physiologic glycosuria, transient glycosuria, traumatic glycosuria, phlorizin glycosuria, renal glycosuria and glycosuria innocens. Diabetes, as a general rule, is a chronic disease. It is not ushered in with the full symptom complex present from the very beginning. Glycosuria, the first symptom, no doubt early in the disease is intermittent in character and is present only after an unusually heavy meal or one of high caloric content. This, if untreated and if of the variety which is a forerunner of a true diabetic condition, becomes more frequent and is present intermittently. This form of glycosuria is called *intermittent glycosuria*. If the intermittent glycosuria shows a tendency to become constant it is significant of a diabetic glycosuria.

The ordinary reagents used in routine laboratory tests are not sensitive enough to detect very minute traces of sugar which are present in practically every urine. Benedict in a personal communication to Allen maintains that his qualitative

test performed according to his later technic will detect glu-
cose in as low a concentration as 0.01 to 0.02 per cent., provided
the urine is of low dilution, therefore a *physiological glycosuria*
is present in practically every normal individual if a very sen-
sitive reagent is used, and it becomes a matter that must be
settled at what percentage a glycosuria will be called patho-
logical. At the present time urine which is negative to the
ordinary laboratory reagents for sugar, *e.g.,* Benedict's,
Fehling's, Haynes', Nylander's and Boettger's, is considered
normal from the standpoint of being physiological or patho-
logical in character.

In normal individuals a meal rich in carbohydrates, es-
pecially if it contains carbohydrate very readily convertible
into glucose, may show sugar temporarily in the urine. If
the body is suddenly overwhelmed with carbohydrate, which
is readily converted into glucose normally, it is unable to prop-
erly care for it and in order to maintain its concentration in the
blood, sugar is excreted in the urine. To this form of glycos-
uria is applied the term *alimentary glycosuria.* The limit of as-
similation of glucose in a normal individual has been vari-
ously stated at from one hundred to two hundred grams given
as a single dose. At the present time one hundred grams of
glucose in a single dose is given to test the assimilating power
of the body. If no glycosuria or deviation in the normal blood
sugar curve is present after this test the individual is con-
sidered to have a normal carbohydrate metabolism.

Transient or *non-diabetic glycosuria* are terms used in the
past, less frequently at the present, to describe sugar present
in the urine following profound depressing emotions, cerebral
concussion, great anxiety, poisoning by drugs, amyl nitrite,
nitrobenzole, carbon monoxide and the ingestion of salicylates
in large doses. Recent information probably suggests that in
some cases the examination of the urine performed during
these conditions resulted in discovering sugar, which may have
existed prior to the onset of the illness.

Phlorizin glycosuria can be produced experimentally by giving
phlorizin to an animal. This drug produces glycosuria regard-
less of whether food is withheld from the animal temporarily,
and it is a matter of indifference as to the kind of food in-
gested. The glycosuria disappears when the administration of

the drug is discontinued. Phlorizin causes glycosuria not by impairing the ability of the body to utilize carbohydrate, but by liberating the carbohydrate already stored in the body, the function of the kidney not being altered.

Renal Glycosuria or Renal Diabetes. Renal glycosuria, or as it is also called, renal diabetes, because glycosuria is the sole symptom, is a condition the identity of which is seriously doubted by very eminent authorities, and reliable observers on the other hand have been fully satisfied that such a condition exists. Recent consensus of opinion seems to confirm the opinion of the latter group.

Renal glycosuria or diabetes, as the terms are incorrectly used interchangeably, is thought to be due to an increased permeability of the renal cells. Though glycosuria exists, the blood sugar content is either normal or may be low. Caballero[5] believes that the difference in the sugar content of the renal artery and the renal vein shows that in this organ sugar is in part destroyed, is in part transformed into other bodies, and is in part eliminated, as a consequence of glandular activity.

In the condition known as renal glycosuria the glycosuria is continuous or may be interrupted for periods which bear no relation to the carbohydrate intake. The percentage of sugar in the urine does not necessarily follow any increase or decrease in the carbohydrate content of the diet and may vary from a trace to five per cent. The blood sugar curve presented in these cases of renal glycosuria are of the greatest importance in establishing the presence of this condition. The sugar content of the blood must not exceed the percentage present in normal individuals following a single dose of 100 grams of glucose taken by mouth, and is usually less than the maximum allowed under normal conditions. If 100 grams of glucose are given by mouth the percentage of blood sugar must return to the fasting level within two hours and be accompanied by the presence of glycosuria. The more or less persistence of glycosuria during fasting, the normal blood sugar concentration regardless of carbohydrate content of the diet, and the absence of other symptoms of diabetes mellitus, characterize the condition described as renal glycosuria or diabetes. No doubt more extensive information will be

available in the near future upon this interesting condition, and it may be subsequently known by its more correct name.

Diabetic Glycosuria. This glycosuria is characterized by having associated with it the clinical and laboratory findings of diabetes. Any one of the previously named glycosurias may precede the actual diabetic glycosuria. It is very important that every effort be made to properly identify each of the glycosurias. This has not always been an easy matter in the past, and undoubtedly had there been as little difficulty then as there is at present with the proper treatment, the same success would have attended the treatment of these cases.

Allen's[6] *Paradoxical Law* states, "Whereas in normal individuals the more sugar is given the more is utilized, the reverse is true in diabetes mellitus." In non-diabetic individuals or in non-diabetic glycosuria, the individual is able to care for an increasing amount of carbohydrate, as increasing amounts of carbohydrate are given. In diabetes, there is a threshold of limit of carbohydrate tolerance which is fixed and contrary to what is present in the non-diabetic. The more that is given in excess of this limit of tolerance, the less carbohydrate as a rule is absorbed, due to the point of tolerance being lowered by the body processes concerned in sugar metabolism which are overwhelmed by carbohydrate. For example, if it is found that the daily tolerance for a diabetic is 75 grams of carbohydrate, if he exceeds this amount taking 80 grams, he excretes 5 grams of carbohydrate in the urine. If he were to take 120 grams daily, instead of maintaining his ability to handle 75 grams his body processes are overwhelmed and the tolerance of 75 grams may be reduced to 60 grams, 50 grams or even less. On the contrary a normal individual can readily handle 400 grams daily. If he were given 475 grams he may be able to handle 465 or even 470 grams and if given 500 grams he may be able to handle 485 grams. In other words, with the increasing amount of carbohydrate he is called upon to handle, just so his ability to handle increased amounts of carbohydrate is also increased. The application of this law, beyond all question, is of the greatest value in determining the type of glycosuria present and thus indicating the measures, if any, needed for its treatment.

**Associated with Disturbances of the Endocrine System
and the Sympathetic Nervous System.** Four ductless glands
have to do with the regulation of the blood sugar in the body
and thus with the production of glycosuria. These glands are
suprarenal, the thyroid gland, the pituitary and the pancreas.
The action of these glands is coördinated through the nervous
system and by means of their secretions.

Nervous stimuli passing from the diabetic center in the
medulla via the sympathetic nervous system to the adrenals
stimulate these glands to activity. An increase in adrenalin
secretions stimulates the liver to an increased output of sugar
stored therein which is thrown into the blood stream, or to
take a decreased amount from the blood stream thereby re-
sulting in a hyperglycemia with an accompanying glycosuria.
The internal secretion of the pancreas on the other hand is
supposed to have an inhibitory effect upon the liver insofar
as its sugar releasing and storing ability is concerned. The
internal secretions of the pancreas is controlled by the glandu-
lar activity of the thyroid gland and hypophysis. In a series
of dogs, after extirpation of the thyroid gland, according to
Holst,[4] Lorand, and later on, Falta and Bertelli constantly
found a hypertrophy and an increased number of the islands of
Langerhans. The same observers and others have found that
sugar tolerance is raised through extirpation of the thyroid,
provided the parathyroids are not removed or injured. And
finally they found that the glycosuria in experimentally pro-
duced diabetes disappeared or decreased after a thyroidec-
tomy.

In myxedema, the islands of Langerhans increase in number
just as the sugar tolerancee is increased. In hyperthyroidism,
sugar tolerance decreases in the same proportion, other things
being equal, as the secretion of the thyroid gland is increased.
Cushing has shown that in the early stages of a tumor of the
hypophysis there is often glycosuria with lowered sugar tol-
erance, later on these findings may return to normal, until in
a more advanced stage in the disease the carbohydrate tol-
erance may become raised.

The relation that glycosuria bears to diabetes and to the dis-
turbances or diseases of the endocrine system is of great im-

portance, more so as it relates to the recognition of the real cause of the glycosuria.

Glycosuria or lessened sugar tolerance is of importance in recognizing disorders of the pituitary and thyroid, especially in the early stages, and has been made use of clinically in establishing their presence. Another important point also to be considered is, that the cause of the glycosuria may originate outside of the pancreas and this possibility must always be kept in mind.

Puncture of the floor of the fourth ventricle (Claude Bernard's *piqûre*) between the nucleus of the eight and tenth pair of cranial nerves, causes a glycosuria. Nervous glycosurias are supposed to have the same origin as those resulting from puncture of the floor of the fourth ventricle. It has been found that by stimulating the central end of a cut vagus nerve a similar effect is produced as *la piqûre,* indicating that the vagus carries the afferent impulse to the fourth ventricle through the cord to the upper thoracic spinal nerve roots, arriving at the liver by the way of the inferior cervical and superior thoracic ganglia. Glycosuria associated with head injuries, concussions, brain tumors, tabes, meningitis, etc., are due to involvement of this nervous arc which has to do with blood sugar regulation and consequently glycosuria. No satisfactory explanation has been made as to how these nervous impulses cause increased hydrolysis of glycogen.

PHYSIOLOGY AND PATHOLOGY OF GLYCOSURIA— PATHOLOGY OF DIABETES MELLITUS.

Considering the marked changes that take place in the body during diabetes one is surprised at the lack of pathology that is found at autopsy. Although not definitely agreed upon, the fault of the disordered metabolism lies primarily with the internal secretion of the pancreas, coming from the portion called the islands of Langerhans. It has been shown experimentally by Von Mering and Minkowski that extirpation of the pancreas of a dog is followed by the phenomena of diabetes mellitus. They did not explain at the time in what way extirpation of the pancreas produced diabetes, but several years later, in 1892, concluded that diabetes following the ex-

tirpation of the pancreas was due to interference with an un-
known function of the pancreas. Some observers believed
that the trauma to the nerves going to the pancreas or the
trauma to the intestines during the extirpation of the pan-
creas was responsible for the diabetic symptoms which fol-
lowed, but this has not been proven. That the symptoms are
due to actual pancreatic tissue loss has been proven, even to
the degree of symptoms being dependent on the amount of
pancreatic tissue removed. If three-fourths to seven-eighths of the
pancreas of a dog is removed a severe form of diabetes results,
while if one-sixth or one-eighth of the pancreas is removed a
very mild form of diabetes becomes manifest.

Lesions, therefore, in diabetes are looked for in the pancreas
although in severe diabetes, lesions cannot be found so severe
as to be equal to the effects caused by the removal of the
greater portion of the gland. ·

The ligation of the pancreatic ducts which carry the external
secretion of the pancreas to the duodenum results in atrophy
of the acini, but since the islands of Langerhans which furnish
the internal secretion are entirely separate from the acini,
the former do not suffer and no glycosuria develops. It is,
therefore, apparent that gross interference with certain parts
of the pancreas may result, without producing glycosuria, so
long as the islands of Langerhans (which are the source of the
internal secretion which have to do with carbohydrate meta-
bolism) are not disturbed. Serious disturbances of the islands
may be effected, with the concomitant results, with very
little evidence of gross pathology being manifest. Where no
pathology is demonstrable in these areas of the pancreas the
alteration must be assumed to be functional in character.

Numerous observers have described changes in the islands
of Langerhans in diabetes which are rather significant. The
change consists of practically all the cells of the islands of
Langerhans being converted into hyaline inert masses, by
which all the cells are destroyed, without the pancreas grossly
presenting any evidence of pathology.

These hyaline masses are the result of hydropic changes,
degenerative in character, consisting of cloudy swelling, fol-
lowed by vacuolation and finally the disappearance of the cells
into hyaline masses.

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The hydropic changes have been brought about by continuously overfeeding animals beyond their carbohydrate tolerance. Sooner or later feeding beyond this tolerance produces permanent destructive changes in the islands of Langerhans.

However, these findings are not uniform in cases of diabetes mellitus of approximately the same clinical degree, and as stated before may not be present to any extent whatsoever. Were this the case the theory of the internal secretion and its relation to diabetes mellitus could easily be proved.

It is seldom that the islands of Langerhans are alone involved, they usually partaking of the process which attacks the pancreas as a whole.

Cecil[7] found that in a large number of patients suffering from diabetes, lesions were found in eighty-seven per cent. The islands of Langerhans were always effected, and in about twelve per cent. no other portion of the pancreas was involved. In the remaining thirteen per cent. in which no change had been found in the pancreas, one could only assume that the changes within the pancreas, if any, were functional or that some lesion outside of the pancreas was responsible for the diabetes.

Other changes in the body in diabetes mellitus outside the pancreas are those found in the blood, liver, muscles and central nervous system.

The changes in concentration of the sugar in the blood are discussed on page 726.

The liver, in which under normal conditions large quantities of glycogen are stored, in diabetes mellitus contains small quantities, if any, of glycogen or carbohydrate. The cells of the liver whose protoplasm contains granules in which carbohydrate in the form of glycogen is found are devoid of this substance and the only glycogen found is in the nucleus of these cells which are now swollen. The skeletal muscles are wasted, because their reserve of glycogen has disappeared. The only tissues of the body in which the glycogen reserve is little disturbed if any, is the heart muscle, the renal epithelium and the leucocytes. Changes in the nervous system described during diabetes mellitus may be the cause of diabetes rather than the effect.

Acute pancreatitis may or may not be accompanied by interference with carbohydrate metabolism. So long as a sufficient number of islands of Langerhans remain intact to properly conduct carbohydrate metabolism, glycosuria does not occur.

Nature of Carbohydrate Metabolism in the Normal and Diabetic Person. With the advent of more readily accessible means for determining metabolism, an increased amount of work has been performed on a larger number of cases than heretofore. The results show that in the case of severe diabetes, with acidosis, the metabolic rate was increased above normal, and that with the proper treatment the acidosis disappeared and the metabolism became sub-normal.

The basal metabolic rate likewise may be found to be above normal in mild cases, or severe cases with acidosis, and below normal in severe cases of diabetes who are undernourished.

When carbohydrate is taken into the body it passes through the various processes of digestion and absorption before it is ultimately utilized by the body. Carbohydrate is essentially an energy producer for the body, and the body is capable of utilizing only monosaccharids such as dextrose (glucose), galactose and levulose. Starches and sugars when taken into the mouth are changed slightly, depending upon the time allowed to remain in contact with the ptyalin of the saliva. They then pass into the stomach and no specific enzyme being present further change does not take place in the carbohydrate until it arrives in the duodenum where it is brought into contact with.the juices of the pancreas. The pancreatic juice is the external secretion which is secreted by the islands of Langerhans and is supposed to be absorbed directly by the blood stream. The pancreatic juice contains lipase, the ferment which acts on fats, the amylopsin which acts on starches, and the trypsin which acts on proteins. The amylopsin changes all starches and sugars to glucose, galactose or levulose, the simple monosaccharids. The starches are hydrolyzed into dextrin, then to dextrose. The cells of the small intestines have the ability to take up the glucose molecules which in turn are discharged by these cells into the portal vein. When the glucose of the portal vein reaches the liver it is polymerized into glycogen and stored as such in the liver cells.

This process is known as glycogenesis and is brought about by a ferment. Next to the liver, the muscles possess the main glycogen reserve of the body. All the cells of the body probably possess to some degree the ability to store glycogen. This glycogen is used in forming more complex substances which may be one of the inherent functions of the particular cell.

When the carbohydrate needs of the body are fully met then carbohydrate is stored so that when it is needed it can be converted from glycogen into glucose. This ability is possessed by the liver and other cells in the body and is known as glycogenolysis. The blood sugar concentration is kept at a fairly constant level and is regulated by a balance between glycogenesis and glycogenolysis. If no carbohydrate or an insufficient amount is taken into the body then the glycogen reserve is called upon to keep the blood sugar normal. Protein in the absence of sufficient carbohydrate to meet the demand, may be converted into carbohydrate. When the glycogen reserve is sufficient in a normal individual the excess of carbohydrate ingested is converted into fat which process is believed to take place in the connective tissues of the body. The end product of carbohydrate combustion is CO_2 and water and the breaking down of glucose in the body is a continuous process. Every action of the body requires glucose. In normal individuals it is not possible to feed starch to the point of producing glycosuria. This is so because the starch is slowly converted into glucose, and consequently at no time is the body called upon to deal with an excessive amount of glucose. It is therefore slowly used or stored. On the other hand in normal individuals large quantities of glucose, 175 to 200 grams, taken on an empty stomach will be promptly absorbed and the body will be called to handle, within a relatively short time, an excessive quantity of glucose. Glycosuria results, as a means of restoring equilibrium. This rarely occurs in a normal individual because the simple forms of carbohydrates are seldom taken in such large amounts. This fact is made use of in the treatment of diabetes, since it is wise in a weakened pancreatic function to bring carbohydrate to it slowly, so that it will not be overwhelmed and, therefore, unable to handle it. This can be accomplished by allowing slowly

digestible forms of carbohydrate, of which the carbohydrate present in oatmeal is a good example.

It has been demonstrated by Woodyat and his coworkers that by giving glucose intravenously in a constant stream a normal individual will utilize about 0.85 grams per kilogram of body weight each hour. The disaccharids (ordinary cane sugar and lactose) when injected intravenously are not absorbed but are entirely excreted. Maltose is the one disaccharid which is utilized when given intravenously.

Under normal conditions carbohydrates when taken by mouth are manufactured by the liver into glycogen. As much as twelve to fifteen per cent. of the weight of the liver may be glycogen. The exact method of glycogen formation is not satisfactorily explained, although it has been thought by some observers to be a diastase reversing its action, which is a common biological phenomenon, with the conversion of glycogen into glucose through the action of the diastatic ferment glycogenase. This ferment is found distributed through all the fluids and tissues of the body. The origin of this ferment, glycogenase, is thought to be in the pancreas which supplies the blood which in turn distributes the enzyme throughout the body. Glycogenolysis can be hastened without an increase of glycogenase by stimulation of the splanchnic nerves. Under normal conditions glycogenolysis is largely under nervous control. It therefore will be seen that variations in the quantity of glycogenase cannot be held responsible for disorders in carbohydrate metabolism.

A third factor which may be called into play in carbohydrate metabolism disorders is glyconeogenesis, which is closely allied to glycogenolysis. When the glycogen reserve in the liver and muscles is exhausted and no carbohydrate is ingested or available because of the inability to utilize it, then the body, principally through the liver, will exercise the property of glyconeogenesis. Thereby sugar is formed from the protein of the body in an endeavor to keep its blood sugar at a constant level. When a person with diabetes does not take any food and is fed entirely on protein, sugar is derived from protein in a constant proportion. Approximately sixty per cent. of the protein molecule can be converted into sugar. By excluding carbohydrate from the diet for three or four days,

all the sugar in the urine of a diabetic must be derived from protein. If the diabetes is total, that is if no sugar is being utilized by the body, and the entire sixty per cent. of the protein molecule is converted into sugar, examination of the urine will show that the ratio that the glucose bears to the nitrogen is as 3.65 : 1 and this expression is known as the "Dextrose Nitrogen Ratio" (D. N. Ratio). In accordance as the D. N. Ratio approaches 3.65 : 1, so the condition approaches a complete diabetic condition. This, however, is not absolutely true, as some of the degree of severity in the diabetic condition at the time of the test may be functional, rather than actual impairment of the islands of Langerhans. Just what part the liver plays in diabetes mellitus has never been definitely settled. Cirrhosis of the liver, of the atrophic and the hypertrophic types, has been found in the diabetic but is to be regarded as secondary to the disease rather than the cause. From what just has been stated it is very evident that the various functions of the liver described have much to do with carbohydrate metabolism. French authors continue to describe and speak of diabetes as purely hepatic in origin but this view has never been generally accepted. Pfluger states that without the liver there can be no diabetes, which is proven in frogs. If the liver of a frog is removed, extirpation of the frog's pancreas will not cause glycosuria. No doubt the relation between the liver and pancreas is very close, the action of the one being capable of influencing the other, and *vice versa.*

The pancreas continues to be the most important organ in regulating carbohydrate metabolism as proved by animal experimentation. Complete removal of the organ regardless of the diet subsequently administered, causes a severe glycosuria accompanied by hyperglycemia. General metabolism is very much disturbed, the animal rapidly emaciates and death results in from two to four weeks preceded by the presence of ketone bodies in the blood. The internal secretion of the pancreas is necessary as proven by the fact that if, in an animal whose pancreas has been extirpated, a small piece of pancreas, with the blood supply preserved sufficiently, is transplanted subcutaneously, glycosuria does not occur. If the transplant is afterward removed glycosuria promptly develops. The ex-

ternal secretion may be so diverted that if this juice is delivered on the skin surface and the animal be entirely deprived of its use, diabetes does not develop, provided the blood received the internal secretion.

Pancreatic diabetes produced experimentally in animals is the only form of glycosuria that resembles diabetes mellitus in man.

It must not be forgotten that glands other than the pancreas play a rôle in carbohydrate metabolism. Following the hypodermic administration of epinephrin, glycosuria occurs the severity of which is dependent in degree upon the epinephrin concentration in the blood. If the pancreas and the adrenals of a dog are both removed glycosuria does not occur. Epinephrin causes glycosuria in the presence of a good glycogen reserve as well as in a fasting dog. In dogs with the adrenals removed and in Addison's disease the tolerance for glucose is increased with a low blood sugar and an absence of glycosuria upon the injection of epinephrin. It is believed that epinephrin acts upon the sympathetic system terminals in the liver. If the liver is separated from the sympathetic system, stimulation of the splanchnic does not cause hyperglycemia, which is the reverse of what takes place under normal conditions. The hypophysis has an action similar to the adrenal on carbohydrate metabolism. A stimulation of the hypophysis by electrical or mechanical means, causes glycosuria, followed by a decreased carbohydrate tolerance. Complete extirpation of the hypophysis is followed by an increased sugar tolerance and a tendency to obesity.

The relation of the thyroid gland and parathyroids to carbohydrate metabolism is also deserving of attention.

If the thyroid and parathyroids are removed the assimilation limit for sugar is greatly decreased. Epinephrin under these conditions produces glycosuria as normally in thyroidectomized dogs, the protein metabolism is reduced and the protein saving qualities of sugar and fat diminished. The Claude Bernard experiment whereby a puncture of the floor of the fourth ventricle of the brain causes a transient glycosuria emphasizes the importance of the influence of the nervous system in carbohydrate metabolism. The production of glycosuria is dependent upon the presence of glycogen in the liver.

If there is no glycogen reserve in the liver, puncture produces
no glycosuria. The impulse from the brain to the liver is *via*
the sympathetic nervous system. Section of the sympathetic
nerves prevents the glycosuria following puncture of the fourth
ventricle. The puncture of the floor of the fourth ventricle and
the hypophysis has the same effect as when the hypophysis
is removed and stimulation of the superior cervical sympa-
thetic ganglion fails to cause glycosuria. The experimental
evidence indicates that under nerve stimulation the hypophysis
and adrenal act in a similar manner in producing glycosuria.

The glands of internal secretions as will be seen are the great
mobilizers of the sugar of the body. The pancreas is the check
upon too great mobilization of the sugar, and normal carbo-
hydrate metabolism is the result of a balance between these
forces.

Nervous influences play an important part by stimulating
the adrenals and as Cannon has shown during emotional states,
the adrenalin content of blood is increased. The thyroid gland
augments the adrenals and inhibits pancreatic function, and,
therefore, removal of the thyroid removes its inhibiting action
on the pancreas and conversely hyperactivity of the thyroid
results in glycosuria. Parathyroids and pancreas on one side
depress or check carbohydrate metabolism while the thyroid,
the chromaffin tissue and the hypophysis stimulate carbohy-
drate mobilization.

In normal individuals the ingestion of 100 grams of glucose
before breakfast results in a normal blood sugar curve. There-
fore any appreciable departure from this standard must be
looked upon with suspicion. Glycosuria does not always mean
diabetes but it should prompt us to a review of the possible
sources of the derangement of carbohydrate metabolism.

SYMPTOMS.

Diabetes is, in the majority of cases, a chronic disorder and
its presence may be unrecognized because of the lack of symp-
toms or the mildness thereof, and on the other hand, the dis-
ease occasionally is ushered in very abruptly. In such cases it
is often impossible to state whether there has been a sudden
aggravation of an existing unrecognized glycosuria or whether

all the symptoms are of very recent origin. Sudden onset or perhaps aggravation of an already existing glycosuria has been discovered following nervous shocks.

The typical symptoms of diabetes mellitus as stated in most text-books are glycosuria associated with increased thirst, increased appetite, increased frequency of urination and an increased quantity of urine, with loss of weight and strength, and emaciation. This entire group of symptoms, or but one or more of them, may be manifest. To have present all the above symptoms in a case of diabetes is to have on hand a well developed and usually a severe case of diabetes. This combination of symptoms can well be compared for degree of severity with the symptoms in a well marked case of pulmonary tuberculosis, *i.e.*, fever, cough, hemoptysis, tubercle bacilli, emaciation and possibly cavity formation. In both instances well advanced cases are being dealt with, and it is the duty of every physician to recognize these two conditions, if possible. in their earlier stages by utilizing all possible means known to medical science.

Increased thirst, increased appetite, increased frequency of urination, increased output of urine, loss of weight and strength are symptoms resulting from altered metabolism especially that of carbohydrates, in consequence of which impaired nutrition results. But one symptom may be present, other than glycosuria. A patient may have an inordinate desire to drink water, with associated frequency of urination. On the other hand no polydypsia may be present, only frequency of urination with no appreciable increase in the amount of urine. In this case the percentage of sugar is usually high, the specific gravity of the urine is above 1.030 and the irritating urine causes frequency of micturition. It is believed by some that in the absence of an increased appetite or an increased desire for sweets, diabetes mellitus need not be considered as a possibility. This view is incorrect and leads to overlooking the presence of this disease. A normal appetite for the usual articles of diet of the average normal individual may be present in the true diabetic early in his course, or he may complain of anorexia, or not necessarily have a desire for sweets.

Loss of weight may be the first symptom complained of.
Not infrequently a patient will apply for treatment because
of asthenia with or without loss of weight. The patient usu-
ally appears to be a healthy normal individual and it is only
by a urinalysis that the true cause of the asthenia is dis-
covered. The asthenia and loss of weight may be due to the
large quantities of urine passed, resulting in an interference
with obtaining the proper rest at night, and in the loss of heat
as the result of the withdrawal of so large a quantity of fluid
from the body. The loss of weight is also due to inability of
the body to store carbohydrate.

In mild diabetics such as occur more commonly after the
age of forty-five or fifty years, the only symptom may be
glycosuria, unassociated with any other symptoms for a con-
siderable length of time. Within the past year there came
under the observation of the writer a patient who developed
a cough following an attack of the grip. The patient was a
business man, age fifty-eight years, who within two months
after contracting the cough developed a very active tuberculo-
sis of the lungs with the presence of tubercle bacilli in the
sputum and a glycosuria. When questioned about the gly-
cosuria the patient stated that fifteen years before he had
applied for additional life insurance but was refused, and on
at least five different occasions since then, on account of gly-
cosuria. He subsequently consulted his physician who told
him to disregard the glycosuria unless he developed symp-
toms whereupon he was instructed to report to his physician.
Until developing this cough, he had no treatment or diet for
the glycosuria, always worked hard and enjoyed the best
of health. During the year previous to his tuberculosis be-
coming active he suffered nocturia, which he attributed to his
advancing years. Several examinations of the urine disclosed
the fact that sugar was present. It can be safely assumed that
as the result of the glycosuria the resistance of the patient
was decreased in the presence of the attack of the grip, and
that probably an old tuberculous lesion was reactivated
which explains his present chest condition. Thus can be seen
the danger of allowing glycosuria to go untreated.

As a general rule the symptoms are more rapid and intense
in the young, but there are exceptions to this rule. Glycosuria

may be present in a potential diabetic individual only at long intervals at first, usually following heavy meals or sometimes in the presence of acute infections or septic conditions. If untreated or not discovered the glycosuria becomes more and more frequent, and finally continuous. There is no doubt but a number of glycosurias have not been recognized because of the failure to examine a specimen from a twenty-four hour collection of urine. For instance the average individual, unless requested otherwise, if asked for a specimen of urine will bring for examination the specimen of the first urine voided in the morning. This specimen being usually taken at a period which represents the longest interval possible after a meal is least apt to show an intermittent glycosuria. If a sample of a twenty-four hour specimen cannot be obtained then the urine collected for a period of two hours after the heartiest meal of the day will answer very well.

The skin of diabetics is usually dry and coarse. In well developed cases contusions received months before may show pigmented remains, being evidence of slow repair. The tongue is usually dry, clean and the mucous membrane of the mouth is dry in well established cases. The saliva may be scanty, and the gums tender and swollen.

The loss of weight in diabetes mellitus may be as rapid as seen in malignant conditions and tuberculosis. This is true in spite of the large quantities of food ingested. The loss of weight under proper treatment is necessary, especially so if the patient has been overweight, and need occasion no alarm. In fact a diabetic patient does better in every respect if kept slightly below weight, as compared with the standard for his height and age. The loss of weight and the wasting frequently results in visceroptosis which will cause gastrointestinal symptoms, such as constipation, gaseous eructions and general abdominal discomfort. The weakness complained of by the patient is not necessarily due to or associated with loss in weight. Properly treated diabetics who have lost weight have greater strength, which is independent of body weight. As a general rule the younger the person the greater the loss of weight, other conditions being the same.

An increase in the amount of urine may or may not be present, although it usually occurs in a well established case,

varying from normal to as much as 20 liters in twenty-
four hours. This increased amount leads to increased fre-
quency so that it may be necessary to void urine every fifteen
minutes while awake. The average patient voids three to
four liters in twenty-four hours. The symptoms thus far dis-
cussed have in the main been due to faulty assimilation and
impaired nutrition.

Another group of conditions, usually described as the com-
plications of diabetes mellitus, are the direct result of lesions
produced by impaired assimilation or bacterial infections as the
result of altered assimilation. It is extremely difficult at times
to draw a sharp line of distinction between what are the com-
plications and what are the symptoms of diabetes mellitus.

In some instances the first evidence of the presence of dia-
betes may be a complication, so that it is equally as important
to be familiar with the possible complications as with the
usual symptoms. As diabetes mellitus is being recognized in
earlier stages and as better methods of treatment are known,
so the number of complications are now fewer in number.
Scarcely any system of the body escapes the possibility of
being involved by a complication as the result of diabetes.
The skin may be attacked by pruritus, furunculosis and car-
buncles which are complications of diabetes mellitus. In
every case of pruritus, diabetes as the etiological factor must
be considered. Pruritus pudendi is a common form and the
writer recently observed a patient who had a dilatation and
curettement of the uterus performed to alleviate what was
thought to be a pruritus pudendi as the result of an irritating
uterine discharge. The urine was examined, glycosuria dis-
covered, and after the operation, which afforded no relief, the
institution of diabetic treatment caused the pruritus to promptly
disappear. The skin of diabetics is very readily infected if the dia-
betic condition is not under proper control. Abrasions, cuts, con-
tusions, incisions at surgical operations either become infected
or heal very slowly, unless the urine of the diabetic is sugar
free.

Subcutaneous or hypodermic injections if necessary should
be given only with the most rigid, surgical asepsis. The same
precaution should be observed in drawing blood from a vein,
to determine the blood sugar content.

Coma, as a complication, is described on page 711.

Furunculosis is a troublesome complication and may be the first good reason to have the urine examined which reveals sugar as the etiological factor. Glycosuria has also been observed to have occurred for the first time during an attack of boils or a carbuncle, only to disappear with the healing of these lesions.

The presence of carbuncles and furuncles in patients who though under treatment are keeping too near to or who are on their "safety line of carbohydrate tolerance" at times causes sugar to appear in the urine, which may offer greater difficulty than is usual, in getting rid of the sugar.

Carbuncles of diabetic origin are not uncommon. They differ in no way from carbuncles in non-diabetics, except in their obstinacy to healing unless proper diet is prescribed in addition to surgery. Death in diabetes may be caused by the complication of carbuncles. Every case of carbuncle should have the urine carefully investigated for sugar, if negative and still diabetes is suspected the blood sugar should be carefully determined. Diseased kidneys may prevent the sugar in the blood from escaping into the urine. Metastatic abscesses and septicemia involving the heart, lungs, liver, kidneys or brain may be the closing issue, in diabetes mellitus complicated by carbuncles.

The first symptom to attract attention in a diabetic may be his mental state. Not infrequently untreated diabetics become very much depressed mentally or suffer a psychosis. This condition is very much improved or disappears when the patient's blood sugar concentration comes within normal range and the urine becomes sugar free as the result of the proper dietetic measures. Two instances of mental disturbances in diabetics came under the author's observation in the past year.

The first case was that of a man aged forty-three years who, it was thought, was worried on account of his business affairs and who suddenly disappeared for a period of three months. After two months wandering about the country he finally regained his normal mental condition after he had been admitted to a hospital where it was found that he had diabetes mellitus. Proper dietetic treatment resulted in the

prompt improvement of the patient's diabetes as well as
recovery from his mental aberration.

Another case was of a merchant fifty-eight years of age who
was also very much depressed without any apparent cause.
A complete physical examination, ordinary urine and blood
examinations revealed nothing abnormal but glycosuria of a
diabetic origin. Proper dietetic treatment greatly improved
his mental condition, in fact when last heard of, the patient's
mental condition was normal and he was enjoying better
health than he had in the previous five years.

Gangrene, though not of skin origin, manifests itself so
evidently in this structure that it will be discussed under this
heading. It is of vascular origin however, and considerable
doubt exists as to whether gangrene is dependent upon the
diabetes for its etiology. The morbid histology of diabetic
gangrene does not differ from that seen in gangrene in non-
diabetics. Gangrene in diabetics under the age of thirty years
is rare, the frequency increasing with age. It is quite possible
that the diseases of the arteries and veins resulting in gangrene
are but part of the general arteriosclerosis, which by involving
the vascular system of the pancreas has lessened its capacity
to functionate to the extent of interfering with carbohydrate
metabolism. On the other hand, more or less continuous
high blood sugar concentrations, higher than contemplated for
transportation by the blood-vessels under normal conditions,
with the concomitant altered body nutrition as the result of
faulty carbohydrate metabolism, are not without their dele-
terious effects on the blood-vessels. The consideration of
gangrene is important from the standpoint of treatment. Sur-
gery must, to give the best results, be accompanied by proper
diabetic treatment in so-called diabetic gangrene. Again in
gangrene, diabetes cannot be excluded as a possible etiological
factor because the urine is sugar-free, for the blood sugar may
be increased above normal, and yet the excretion of sugar in
the urine be absent (which with normal kidneys would be
present) because of arterial degeneration in the kidneys.

In a series of 897 diabetics coming under Joslin's[1] ob-
servation, gangrene has occurred in twenty-three cases,
fifteen males and eight females. One patient was under
thirty years of age, one patient in the period of thirty to fifty

years, six in the decade from fifty to sixty years, nine be-
tween the ages from sixty to seventy years and six within the
age of from seventy to eighty years. Usually the gangrene
occurred after the diabetes had existed for more than several years.
Gangrene did not occur in any but the lower extremities.

Massary and Girard[8] describe a case of gangrene in diabetes
which was the result of syphlitic changes in the blood-vessels.
In two other cases the gangrene resulted from infection of
trophic ulceration of the foot. Observations made by Hertz[9]
on the blood-pressure and pulsation in the various arteries of
fifty-three diabetics found that the pulse was very much
weaker below the knee than in the thigh and arm. He ascribes
this to the specific obstruction to the permeability of the
arteries of the leg before it can be noticed in any other way.
In his series, thirty were private patients and the blood-pres-
sure in these cases was always higher than in his hospital patients.
Gangrene as a general rule, is brought on by causes which
develop slowly, therefore sufficient warning may be given to
anticipate its occurrence. In diabetic gangrene, as in non-
diabetic gangrene, coldness and numbness or tingling in the
extremities, or pain and intermittent claudication are fore-
boding symptoms and signs of its actual occurrence.

In Joslin's series of twenty-three cases of gangrene, ten
were treated medically, all of which died in less than one year
after the onset; thirteen patients received surgical treatment,
four of which died within one year after operation; three pa-
tients lived one year, one patient lived two years, one patient
lived five years, one patient lived six years, and one lived
eight years. Of the two of the thirteen patients still living
after surgical treatment, one is alive one year after operation
and one four years after operation.

Complications Referable to the Eyes. Affections of the eyes
are frequent and may be the first indications that the patient
has a glycosuria. Almost any of the common diseases of the
eyes may be caused by glycosuria. In long standing cases of
diabetes and in elderly persons when put on modern anti-
diabetic diet, most remarkable improvement in the vision has
been noted. Failing eyesight, ascribed to oncoming old age is
often greatly improved when the diabetes is properly treated.
Retinitis is one of the most common affections of all the dis-

orders of vision in diabetes. The retinitis may be due to associated renal involvement. Hemorrhagic retinitis may occur, to be followed by optic neuritis with subsequent optic atrophy.

Cataract of the eyes occurs in both the old and the young diabetic. Iritis, sudden amaurosis without opthalmoscopic changes, myopias are among other disorders of vision encountered in diabetes. Many of these conditions of the eye cannot be remedied by anti-diabetic treatment unless the disorder is discovered at a very early stage and promptly and properly treated. The modern treatment consists wholly of an intelligent selection of the amount and kind of food and is of the greatest benefit in restoring the vision, especially before the changes in the eye are in the nature of being permanent. The diabetic patient often complains of enfeebled vision during the period of starvation in which the salt and water balance may have been disturbed. This condition is usually only temporary and disappears after the urine becomes sugar free and the proper dietetic régime is followed.

Neuritis. One should never see a patient suffering with neuritis or conditions resembling neuritis without thinking of the possibility of it being diabetic in origin. Again we have a condition, in neuritis, which though described as a complication of diabetes mellitus may be the first subjective symptom complained of by the patient. Neuritis in the arms, face and lower extremities are the common points of attack. Sciatica is not an uncommon form of neuritis present in diabetes. The question has been raised as to whether some of the forms of neuritis, especially sciatic neuritis may not be due to the lack of support afforded by the wasting muscles in diabetes. Again the possibility of impaired nutrition to nerve tissue as well as a poor circulation must be considered as factors in the excitation of neuritis. Ofttimes when a neuritis has begun, the relief from diabetic treatment or any other form of treatment is very slow in being evident, in fact may be delayed for a considerable length of time. With focal infections of the teeth, tonsils, and gall-bladder as other possible sources of infection in neuritis, the mere presence of glycosuria, with or without symptoms, cannot be held responsible for neuritis until the former causes are eliminated. The continuance of these foci of infection after a diabetic has been rendered sugar free will

not have much of an effect in relieving a neuritis of focal infection origin.

Acidosis. This is a condition often found present in improperly or untreated diabetes and while not a part of the clinical entity it is a complication so dangerous as to demand a thorough understanding of what is known of its mechanism, its clinical manifestation and means of recognition in order to prevent if possible, or when necessary to institute treatment.

Henderson[10] defines acidosis as "any modification of the normal equilibrium between the acids and bases within the organism whereby the power to neutralize acids is diminished."

Acidosis may result from one or both of the following conditions:

An excessive production of normal or abnormal acids such as occur in the incomplete oxidation of fatty acids, as in diabetes mellitus; or in the retention of acids, as in diseases of the kidneys.

The body has a very complete mechanism to protect itself against a disturbance of the normal acid base equilibrium. The blood and the body fluids are carefully maintained constant in reaction which is slightly alkaline. A change of the normal reaction of the blood is not compatible with life. The blood and body fluids are constantly having introduced into and withdrawn from their substances acids and alkalies without changing its reaction. From without, the body receives foods which furnish alkali and acid and from within, during metabolism, acids and alkalies are being formed. Various mechanisms enter into this protection by which the blood maintains its slightly alkaline reaction under normal conditions.

Carbon dioxide in the form of carbonic acid is a volatile acid which is constantly being produced in large quantities in the tissues of the body and is carried largely by the blood to the lungs where it is given up by the blood and exhaled in the expired air. This is made possible by the lower concentration of CO_2 in the inhaled air as compared with the carbon dioxide of the blood which causes the CO_2 to flow from the higher concentration of the body tissues to the blood, then to the lower CO_2 concentration of the alveolar air.

A second method of protecting the body against the development of acidosis is the ability of the blood, due to its chemi-

cal composition, to absorb acids or alkalies without changing its hydrogen ion concentration, that is by not producing any change in its acidity or alkalinity. This property of the blood is known as its buffer action. The buffer substances of the blood are the sodium bicarbonate, the phosphate of sodium and of potassium and protein substances. These substances are capable of combining with non-volatile acids such as lactic, sulphuric and oxybutyric without changing the reaction of the blood and are eliminated through the kidneys as the sodium or potassium salt. As the result of the bicarbonates of the blood being used to furnish the bases for non-volatile acids, CO_2 accumulates in increased quantities which stimulates the respiratory center in the brain, which in turn becomes more active and the excess of carbonic acid is eliminated by increased pulmonary ventilation, clinically recognized as hyperpnea.

Protein acts as a buffer substance in a manner which has not been satisfactorily explained and so far as is known is unimportant as buffer substances when compared with the sodium salts. It is known, however, that proteins are capable of reacting favorably either with acids or alkalies. Another method by which the body defends itself against a change in its acid base equilibrium is by its ability to convert urea into ammonia thereby supplying additional alkali. The production of ammonia from urea is called forth after the other alkalies have become depleted or show signs of being less in amount.

Another important factor in the protection of the organism against a change in reaction of blood and body fluid is the ability of the body to excrete acid urine from alkaline blood. Disodium acid phosphate in the blood is eliminated as monosodium acid phosphate thereby saving a molecule of sodium. By this method the alkali reserve of the blood is retained at a greater level than would be possible were the disodium salt eliminated as such. Important and outstanding as the described defenses are in the main, nevertheless there are many other minor, though essential, factors in the organism involved in protecting the body against alterations in the reaction of the blood or alkaline fluids.

Attempts to define by stating in terms of physico-chemical changes when the condition of beginning acidosis is present

have failed. As stated before a true acidosis implies an increase of the hydrogen ion concentration (increased acidity) a condition which is not compatible with life.

Clinically we attempt to recognize acidosis in the early stages when the alkali reserve, or the buffer substances, are decreased but not in sufficient quantity to alter the reaction in the blood. The means at our disposal as aids in the recognition of this condition are the examination of the blood, urine, and expired air for evidence of the depletion of the alkali reserve.

Calvert and his coworkers[11] classify these tests as follows:

A. Examination of the blood.
    (1) Determination of titratable alkalinity of the plasma
    (2) Estimation of the plasma bicarbonate CO_2 content.
    (3) Examination of the dissociation curve of oxyhemaglobin or determination of the $Ch+$ at constant CO_2 pressure.

B. Determination of the alveolar CO_2 pressure.

C. Examination of the acid base output by the kidneys.

D. Observation of the effects produced by the ingestion of alkali on the acid base output by the kidneys (*e.g.,* the Sellards alkali retention test.)

The Sellards retention test consists in determining the amount of alkali which must be given before it is excreted in sufficient quantity to render the urine alkaline to litmus. Sellards pointed out that 10 grams of bicarbonate given by mouth is the normal maximum alkali tolerance. Even in a mild diabetic acidosis, this amount is greater than is necessary in healthy individuals while in the more severe cases, doses up to 200 grams of bicarbonate of soda may have to be given before an alkaline urine is passed. This, then, is a simple, accurate test for determining the existence of, and to an extent, the degree of acidosis.

The respiratory air furnishes reliable information as to the presence or absence of acidosis by means of the estimation of its carbon dioxide content or tension, as it is designated in the literature. Any change in the concentration of the carbon dioxide in the blood is readily shown in a proportionate change in the concentration of CO_2 in the expired air. Normally the carbon dioxide content of the alveolar air is equivalent to 5.3 to 6.3 per cent. which is equivalent to a tension varying

from 38 to 45 millimeters of mercury. A slight degree is said to exist when the carbon dioxide is reduced to from 32 to 36 millimeters of mercury. Extreme acidosis is present when a carbon dioxide tension of 25 millimeters or less of Hg is present. A carbon dioxide tension of less than 15 millimeters of mercury is invariably fatal.

The value of estimation of CO_2 tension must be considered in connection with low caloric diets, vomiting and disturbances in the excitability of the respiratory center. In a patient taking little or no food the estimation of the CO_2 tension would be no criterion as to the degree of acidosis present as the starvation in itself would be productive of a lowered CO_2 tension.

A number of methods, Marriott's, Haldane and Friderica, may be used to determine the carbon dioxide tension. Marriott's method is simple, accurate enough for clinical purposes, easily performed and inexpensive.

Examinations of the urine for evidence of acidosis have been used routinely and more or less commonly as compared with other tests. It must be remembered that the examination of the urine shows only what is excreted from the body and not what is retained by the body. The presence of diacetic acid and acetone in the urine are confirmatory and suspicious evidence of acidosis but their absence alone does not negative its diagnosis, while on the contrary a severe acidosis may exist without any diacetic acid or acetone being detected in the urine. Certainly the presence of acetonuria or its absence is no true index to the degree of acidosis that may or may not be present.

The acids commonly tested for in the urine in suspected acidosis are diacetic acid and acetone. The acids responsible for acidosis in diabetes are oxybutyric, diacetic acid and acetone, these being in order oxidation products of one another and are called ketone bodies. The increase in the ammonia nitrogen of the urine as compared to the total nitrogen is a very reliable index to the presence and degree of acidosis. In the normal individual the ammonia nitrogen is about 4 per cent. of the total nitrogen varying from five-tenths to one gram in twenty-four hours. The urea of the body is converted into ammonia compounds to conserve the alkali reserve and hence the ammonia in the urine is increased in direct pro-

portion to the degree to which the body is called upon for increased alkali from urea. In the presence of the administration of alkali it is obvious that the ammonia nitrogen is no longer a reliable index as to the degree of acidosis. One gram of ammonia can neutralize five times as much B-oxybutyric acid as one gram of bicarbonate of soda.

Examination of the blood would seem to furnish reliable and accurate information as to the degree and presence of acidosis, it being the most direct method.

Van Slykes' method of estimating the alkali reserve of the blood is a reliable test. The amount of carbon dioxide in the blood of normal adults is from sixty-three to seventy-five volumes per cent. When the volume per cent. falls below fifty, acidosis is present.

The Rothera nitroprusside reaction in the blood plasma of diabetes is a very reliable test for acidosis.

Diabetic acidosis is the abnormal formation during the course of this disease of the ketone bodies, *viz*: B-oxybutyric acid, diacetic acid and acetone. In diabetes, the abnormal formation of these acid bodies can be detected by finding them present in the blood and urine by the Rothera nitroprusside test. It is generally believed that the acetone bodies result from the imperfect combustion of fats, either as intermediary products or, as thought by some, to be wholly pathological as the result of altered metabolism of fats, carbohydrates and to a less extent protein, because of the latter's capability of yielding, on conversion, sixty per cent. carbohydrate either prevents the formation of these bodies or facilitates their use or destruction. In case of starvation, or a disease as diabetes mellitus, or a carbohydrate free diet, there is a diminution in the carbohydrate metabolism, with the result that acidosis appears. Carbohydrate, therefore, is necessary as a flame in which the fats may be completely oxided to CO_2 and water. It is believed that for every three molecules of higher fatty acids to be completely oxidized to CO_2 and water, one molecule of glucose is necessary. Less amounts of carbohydrate result in imperfect fat metabolism and the formation of acid bodies.

When an animal is starved the body turns to its storehouse of fat, carbohydrate and protein for its supply of food.

Carbohydrate, being used in excess of the other two substances as a source of fuel for the oxidation processes of the body, is more rapidly reduced in amount than the fat and protein and soon the ratio between fat and carbohydrate is disturbed. This disturbance takes place in an obese person more quickly than in an individual with no excessive amount of fat.

The same effect is noted if a patient is given a diet high in fat content, and low in carbohydrate. The necessary carbohydrate to oxidize completely the fat is absent and acidosis promptly becomes manifest.

In a diabetic the ability to utilize, which means to store or to oxidize the carbohydrate, is impaired and glucose can not be oxidized or stored readily as in the normal individual.

If a normal person, not necessarily obese, lives three or four successive days on a diet in which no carbohydrate is present, the urine at the end of this period will show the acid bodies, and the breath is usually scented with the odor of acetone. Complete fasting likewise produces acidosis and this condition increases for a number of days, and depending on the length of the fast, may become less or disappear as the body adjusts itself to the new conditions. Usually a diet in the normal individual must contain 100 or more grams of carbohydrate to prevent the appearance of acidosis.

In diabetes, on account of the inability of the body to utilize the carbohydrate, the same condition exists to varying degrees as in a normal individual deprived of sufficient carbohydrate or on an absolute fast. It is noted therefore that because of the very nature of the illness, diabetes, it is very much easier for a diabetic than it is for a normal person to acquire acidosis.

Joslin[1] states that a moderate acidosis represented by the excretion of five to ten grams of B-oxybutyric acid, the elimination of two grams of ammonia or a fall of carbonic acid in the alveolar air to four per cent., a pressure of 29 millimeters of mercury, may or may not be harmful to an individual. In chronic and long standing cases this degree of acidosis is of little significance but when recently acquired it should be treated to prevent it from becoming a more dangerous condition. An acidosis may be considered to be severe if the twenty-four hour excretion of B-oxybutyric acid reaches thirty

grams, the ammonia reaches five grams, or when the carbon dioxide tension is three per cent. the equivalent of a pressure of twenty-two millimeters of mercury.

Among the factors which bear upon the severity and prognosis in cases of acidosis in diabetes mellitus are age, amount of acid bodies present, onset, and condition of the kidneys.

Acidosis of gradual onset usually yields to treatment more satisfactorily than if sudden in onset. Children appear to be less susceptible to acid bodies than older people, especially those past the age of fifty years. The condition of the kidneys that are diseased hinders the excretion of acid bodies and thereby increases their retention in the body and makes the presence of acidosis a greater danger, more difficult to treat, and the prognosis correspondingly less favorable.

Diabetic Coma. As the result of the development of increasing acidosis, diabetic coma develops in the course of diabetes mellitus. No fixed law can be laid down as to the degree or extent that the acidosis must reach before coma becomes manifest. A wide variation exists as to when coma will develop. This is due to a number of factors, such as the condition of the kidneys, the storage of carbohydrates and protein, and the condition of the protective mechanism of the body against acidosis. The onset of coma, therefore, may be due to starvation, actually self-induced, or in restricting too greatly the carbohydrate, or increasing the fat content of the diet. Acute illnesses developing in a patient with diabetes mellitus in which acidosis may or may not have been associated may eventually, if not properly treated, result in coma. Starvation as the result of vomiting as in an acute gastroenteritis may be responsible for coma.

Coma, as a general rule, comes on very insiduously and in every case of diabetes, regardless of its mildness, one should always bear in mind that coma may possibly be developing. One or more of the following symptoms may indicate the beginning of coma; drowsiness, restlessness, deep breathing, a decreased or an increased respiratory rate, fatigue, headache, loss of appetite and vomiting. If the condition remains untreated the dullness, which is often the earliest symptom, increases until the patient goes into stupor from which he may be aroused, finally deepening into absolute coma.

The pupils of the eye react to light and accommodation and are equal. The pulse rate is increased but is usually full and strong. The absence of cyanosis in the presence of hyperpnea is characteristic of diabetic coma. The temperature is usually subnormal and skin and mucous membranes dry. Coma has followed surgical operations, acute alcoholism, unusual physical or mental effort, and a high fat diet, and sometimes occurs during acute infections.

A diabetic becoming comatose as the result of uremia or apoplexy, clinically may be suspected of having diabetic coma. Laboratory tests will be of value in fixing the responsibility for the coma.

Coma, having definitely set in, if uninfluenced by treatment is usually fatal in from eighteen to thirty-six hours.

The bowels and bladder are commonly incontinent. The tension of the eyeball usually becomes very much less during diabetic coma.

Finally it must be remembered that known diabetics may become comatose from other causes than diet, as from an early pneumonia or other acute infection, from chemical poisons and as the result of acute alcoholism or fracture of the skull.

Examination of the urine during diabetic coma may reveal a urine with a low normal or high specific gravity, with varying percentages of sugar, to an entire absence of sugar, but with the presence of ketone bodies—beta-oxybutyric acid, acetoacetic acid and acetone. Albumin and casts may be present. The sudden decrease in the amount of urine voided ofttimes precedes the onset of coma.

COMPLICATIONS.

Tuberculosis. As a complication, tuberculosis manifests itself in diabetes often before one is aware of its presence, and indeed one may be surprised at autopsy to find tuberculosis well advanced, in a diabetic who was thought to be losing ground although his diabetic treatment was being well cared for. This again emphasizes the fact that the diabetic is just as likely to contract any other disease as a normal individual may and one should not become so engrossed in the treatment of his diabetic condition that he is blinded to other

possibilities. The diabetic may have an old healed lesion in the lungs or in some other part of the body and due to an untreated or improperly treated diabetes mellitus his resistance will be so much lowered that the tuberculosis becomes active. According to Montgomery[12] tuberculosis did not occur in diabetics any more frequently than in non-diabetics. He found that in a series of 111 cases of diabetes, 9 had evidences of an active tuberculous lesion of the lungs and one had adrenal tuberculosis.

Sixty cases of Montgomery's series of 111 cases of diabetes mellitus were fatal, which included the 9 cases of pulmonary tuberculosis and one of adrenal tuberculosis. Of the 51 non-fatal cases of diabetes mellitus none had any active tuberculosis of the lungs. Out of the records of 355 autopsies performed on diabetics collected from the literature by Landis, Funk and Montgomery[13] 38.9 per cent. showed pulmonary tuberculosis, mostly in the acute form.

Joslin[1] reports 29 cases of tuberculosis in a series of from 900 to 1000 cases of diabetes mellitus. Twenty-five of this series have died and the remaining four have undoubtedly, he believes, tubercle bacilli in their sputum. At the time of his report six of the 25 cases which were fatal died in coma. This low percentage of coma as a cause of death in diabetics he believes to be due to lack of food taken in the advanced stages of the combined diseases.

The frequency of diabetes and glycosuria in active pulmonary tuberculosis on the other hand must be very rare because of the nature of the illness (active pulmonary tuberculosis) which does not furnish the favorable background for the development of diabetes. According to Landis, Funk and Montgomery[13] among 31,834 cases of tuberculosis of the lungs collected from twenty-five tuberculosis sanatoria and hospitals in various parts of the United States there were 101 cases of glycosuria and 51 cases of diabetes. Some of the glycosurias were, they believe, diabetic glycosurias so that the percentage of diabetics in 31,834 cases of tuberculosis ranged somewhere between one-third and one-sixth of one per cent. According to autopsy statistics collected by them the frequency of diabetes in pulmonary tuberculosis varies as follows:

	Pulmonary tuberculosis	Diabetes mellitus
Reports of the Surgeon General, Public Health, and Marine Service, 1895 to 1905	373	0
Henry Phipps Institute until end of 1910	479	1
Jefferson Hospital Tuberculosis Department	110	1
Adami and McCrae; Pulmonary Tuberculosis with County Foundation	85	4
	1047	6

Six cases of diabetes in 1047 autopsies does not, of course, preclude the possibility of the tuberculosis complicating the diabetes mellitus. It is not so readily conceivable, in our present state of knowledge concerning diabetes, that the conditions in active pulmonary tuberculosis are favorable for the development of diabetes mellitus where no evidence of the latter existed prior to the onset of tuberculosis.

Likewise it must not be forgotten that all reductions by Fehling's and other similar solutions are not due to glucose and that not every glycosuria is diabetic in origin or predisposes to diabetes mellitus. Writers differ very widely on several of the clinical findings when diabetes mellitus is complicated with pulmonary tuberculosis. Joslin[1] states that his experience agrees with other writers in the rarity of the hemoptysis. Van Noorden noted its occurrence in 12 per cent. of the cases in which the two diseases under discussion were associated. Shively[14] found hemoptysis frequent and considerable in amount in four out of six cases. In the twelve cases reported by Landis, Funk and Montgomery,[13] they found hemoptysis in every case.

The presence of tubercle bacilli in the associated disease is not uniform according to the different observers. Landis, Funk and Montgomery[13] found the bacilli present in ten out of twelve cases, Van Noorden failed to find them in four open cases with copious sputum and in a fifth (far advanced) case only after repeated search were a few tubercle bacilli found. Shively[14] found the tubercle bacilli in three out of six cases. It is possible that in the advanced cases with many tubercle bacilli in the sputum, because of the emaciation and inability to take very much food the diabetic symptoms disappeared. The same difficulty at times may be encountered in finding the tubercle bacilli present in the sputum in tuberculous pa-

tients with diabetes that is encountered in the sputum of the non-diabetic with pulmonary tuberculosis.

Finally, in tuberculosis of the lungs and diabetes mellitus, although having much in common in symptomatology, the best we can hope for is an arrest of the conditions, rather than an actual cure. The largest number of cases are chronic in duration with emaciation and loss of strength, symptoms common to both diseases, which are more fatal early in life than if they become manifest later in life.

The predisposing causes of diabetes mellitus and pulmonary tuberculosis seem to lie in opposite directions. Diabetes mellitus has a frequent occurrence among the obese, overweight, heavy eaters, while tuberculosis not infrequently attacks the normal or underweight, poor eater and poorly developed individuals.

In a recent observation made by the writer on a series of forty-five men who had glycosuria, but one had a family history of tuberculosis, none had a personal history of having had the disease.

Pregnancy. The diabetic patient may become pregnant and the pregnant woman at times develops diabetes mellitus. It is not uncommon to discover glycosuria in the urine of a pregnant woman, the subsequent course of which, unless treated properly, may follow one of three following lines: First, to entirely disappear after delivery; second, to reappear in subsequent pregnancies and again disappear following delivery; third, to remain as a glycosuria, which increases in severity to ultimately become associated with other diabetic symptoms or complications. Certainly all other things being equal the physician has a greater responsibility in the treatment of a pregnant patient with diabetes mellitus than he has in an uncomplicated pregnancy. The discovery of pregnancy in a diabetic patient or diabetes mellitus developing during pregnancy in the past and ofttimes at present is viewed by many general practitioners with a great deal of alarm. Before the more efficient methods of treatment of diabetes mellitus of the present day were in vogue, the alarm felt by the general practitioner was fully justified since no better treatment for the pregnant diabetic was possible than for the uncomplicated diabetic. In the severer form of diabetes, pregnancy very

seldom occurs, due to the fact that patients suffer amenor-
rhea early and are therefore spared by the conservative powers
of nature from the additional drain of vital forces by preg-
nancy. The unfavorable outcome of the pregnant diabetic is
usually due to failure to recognize the condition early, or if recog-
nized not to carry out the proper treatment, either by failure
of coöperation on the part of the patient or due to the lack of
understanding of modern treatment on the part of the phy-
sician.

In examining the urine of a pregnant patient it is neces-
sary to get a sample of urine as early as possible in pregnancy
to look for sugar as well as for albumin, remembering that al-
though the physician knows that his patient's urine has never
shown sugar heretofore, nevertheless that during pregnancy,
glycosuria may appear for the first time. This thought must
be kept in mind especialy in connection with patients who have
a family history of diabetes mellitus or obesity.

The dangers of allowing diabetes during pregnancy to go un-
treated are those which accompany diabetes mellitus in the
non-pregnant, plus abortions, with increased susceptibility to
acidosis and ultimately diabetic coma, the greatest causes
of the fatal issue in the past.

Some physicians insist that the presence of diabetes mel-
litus either having occurred before pregnancy or during this
period calls for a prompt emptying of the uterus. The proced-
ure is thought to be necessary to prevent the diabetes from
becoming progressively worse and to prevent the develop-
ment of toxemia of pregnancy or acidosis with coma. In the
absence of careful utilization of the diabetic measures as prac-
ticed according to present day methods, this treatment may
have been indicated but with the additional information we
possess today, these measures are to be thought of only after
diet fails.

Ofttimes during pregnancy patients have a craving for an
unduly large amount of food. This may be for either carbo-
hydrates, protein or fat. Unusual amounts of carbohydrate
may be dangerous in the presence of a diabetic tendency or
glycosuria. Rich and fatty substances when taken in excessive
amounts may precipitate acidosis in the presence of mild dia-

betes mellitus, and are even more likely to do so in the presence of a well developed or advanced case of diabetes mellitus.

The treatment of diabetes mellitus in pregnancy or pregnancy in diabetes differs in no way from that employed for the non-pregnant diabetic.

It is important, as stated before, that the urine of every pregnant patient be examined early and often for the presence of glucose and if found that the patient be properly treated and kept under constant supervision. Toxemia of pregnancy must be differentiated from the acidosis of diabetes mellitus. The presence of glycosuria in a pregnant woman calls for treatment and supervision during pregnancy and even if the glycosuria disappears after delivery the urine should be examined at intervals since this may be an indication that the patient is a potential diabetic.

Nursing following confinement, according to Joslin,[1] is not contraindicated.

Inasmuch as surgical procedures requiring general anesthetics are frequently needed it must be remembered that ether anesthesia is more dangerous than nitrous oxide and oxygen and local anesthesia is safer than a general anesthesia. Chloroform is contraindicated as an anesthetic.

The exhaustion accompanying prolonged labor with its possible complications may be attended by greater dangers in diabetics than a rapidly performed cesarian operation under nitrous oxide and oxygen by a competent surgeon.

Surgery. Surgeons, because of the unsatisfactory results obtained following surgical intervention in diabetics, often hesitate applying measures because of an existing diabetes mellitus, which in non-diabetics would be applied early and effectively. The reasons for the unfavorable results obtained are not that the patient does not do well during the operation but rather the development of acidosis and other complications, such as coma, following the operation.*

Foster[15] states that in reviewing the records of two good hospitals he found that of the fatal cases of diabetes mellitus dying beyond the third decade of life about sixty per cent. of the fatalities occurred following a surgical operation. The cause of death in seventy per cent. of the diabetics who were

* The risk has been greatly reduced since insulin has been added to our armamentarium for treatment in conjunction with dietary measures. See further discussion of the use of insulin on page 755.

operated upon was acidosis and diabetic coma. In diabetics.
wounds do not heal as rapidly or tissues do not endure the
trauma as well as do non-diabetics or properly treated dia-
betics. Allen[36] in his animals found that an excess of sugar
in the blood did not retard healing of the wounds, neverthe-
less it is a well recognized clinical fact that undernourished
tissues, if they can be so termed, in chronic diabetics, are more
easily infected, as manifested by the relative frequency of boils.
cellulitis, carbuncles, infected ingrown toe-nails, and skin
abrasions, etc., and that the healing of these lesions is ex-
pedited by instituting a diet, which will render the urine sugar
free and turn the blood sugar concentration toward normal
limits. Chronic diabetics who have gone for months without
proper treatment and who have suffered the weakness and
emaciation accompanying this disorder, have their capacity
for withstanding the physical and mental effort required in
undergoing surgical operations very much reduced, hence the
surgical risk in these patients is materially increased.

Surgery is needed in patients with diabetes mellitus who may
have acute surgical conditions either suppurative or non-sup-
purative, or chronic surgical conditions with or without in-
fection and suppuration.

In a diabetic patient suffering a fracture or a crushed ex-
tremity, all other conditions being equal, the risk of surgical
intervention is greater in the presence than in the absence of
infection. This observation of itself indicates the danger of
postponing surgical intervention on account of diabetes until
actual infection sets in. Surgery may be the only hope, yet
because of the infection, the risk is greater than if surgery
had been resorted to before infection was evident. In the pres-
ence of a severe rhinitis or tonsillitis in a diabetic even though
the patient be under control by treatment, sugar tolerance is
often very much lowered and acidosis readily becomes mani-
fest. If prompt surgical intervention is necessary and there is
not sufficient time to render the urine sugar free and restore
normal blood sugar concentration, the danger is less if there
is an absence of acetone and diacetic acid. The presence of
acidosis calls for prompt and active treatment, as described on
page 755. Since in the presence of infection the surgical
risk in a diabetic is greatly increased, because of the decreased

carbohydrate tolerance and because, not infrequently in the absence of fasting acidosis becomes manifest or if present rapidly increases, fat in the diet should be promptly eliminated.

If starvation increases acidosis, as it may at times in the presence of infection, small quantities of carbohydrate may be given for the purpose of determining if the acidosis may be lessened. If acidosis continues or becomes worse, solely a protein diet may be tried, giving the white of eggs and lean meat, always bearing in mind the advantages of keeping the diet about 250 to 300 calories a day for an adult at the beginning. Each case of acidosis in the presence of surgical infection is a law unto itself, but the foregoing is in principle the best we have to offer in the present state of our knowledge in association with the modern treatment of acidosis.

The results obtained in the treatment of acidosis by the ingestion of alkali are not uniform and its use may cause nausea and indigestion which very materially interfere with the absorption of fluids which is so necessary. If bicarbonate of soda is used and improvement is noted without ill effects, there can be no serious objection to its use. The bicarbonate of soda can be given by mouth in doses of 20 to 40 grains every three or four hours, or by rectum in 5 per cent. solution. Foster[15] states that he has given sodium bicarbonate in olive oil subcutaneously, 10 to 15 grains in 10 c.c. of oil emulsified, as suggested to him by S. R. Benedict.

If the surgical condition is one in which no infection is present and if surgery can be postponed for a week or more, until correct dietetic treatment can be instituted the surgical risk may be reduced to a minimum. Accompanying the dietetic treatment must be the disappearance of glycosuria with the return of the blood sugar concentration to within normal limits, with no evidence of acidosis, and the resulting increase in the carbohydrate tolerance. This routine treatment would be applicable to a diabetic afflicted with cancer.

Very much the same condition must be obtained in a chronic infection, such as chronic osteomyelitis with a small amount of pus discharging from the wound. Here the diet must be slowly changed, eliminating first fat entirely, keeping up the elimination, by the ingestion of an abundance of liquids. The bowels must be kept well opened. Bicarbonate of soda, 20

grains, given orally every four hours until the urine is alkaline and then sufficient to keep the urine alkaline may be of the greatest value in preventing acidosis in these cases. A sudden change in the diet in an infection of long standing may pre- cipitate acidosis and coma if not carefully managed.

There can be no doubt but that the kind of anesthetics used and the length of time the diabetic patient remains under the influence of the drug is an important factor in the subsequent course of the diabetic patient who undergoes surgical opera- tions. An observation with which we are all familiar is that at times in a normal individual following the taking of chloro- form or ether as a general anesthetic, glucose with or without ketone bodies appears in the urine. It is therefore obvious that additional risk is present in a diabetic under the same con- ditions.

Chloroform is contraindicated on account of the great danger to a diabetic. Ether, though less dangerous, has been suc- cessfully used. Its use is coupled with definite risk though much less than with chloroform.

It would appear that the safest general anesthetic is nitrous oxide and oxygen.

Regardless of the anesthetic used it should be given in as small quantities as necessary to obtain the degree of narcosis needed and for as brief a time as required to perform the operation. With regard to the use of local anesthetics, they do not carry with them the dangers of a general anesthetic, but the mental quietude is not obtained. It is essential that sufficient opiate be given to diminish the danger of glycosuria and acidosis, which so often increases as the result of the accompanying mental strain.

Local infiltration should be limited to as small an area of tissue as possible, on account of the necessary trauma, and the possibility of infection from the devitalization of diabetic tissues. Where spinal anesthesia is used the same measures to obtain mental relaxation should be taken as in the use of local anesthetics. Joslin[1] reports that omitting operations for gangrene and carbuncles, surgeons have performed the fol- lowing 29 major operations upon his diabetic patients with six deaths, as follows:

Operation	Total No. of cases	Results	
		Successful	Fatal
Gall-stones	3	3	0
Appendicitis	5	2	3
Cancer { Breast	1	1	0
Bladder	3	1	2*
Uterus	1	1	0
Prostate (removal)	4	4	0
Fibroid (uterine)	5	4	1
Extensive perineal repairs	3	3	0
Exploratory laparotomy	1	1	0
Amputation, leg for septic knee	1	1	0
Mastoid	2	2	0
Total	29	23	6

Factors to be taken into consideration in the determination of the severity of the diabetes are the glycosuria, the blood sugar concentration and the blood sugar curve obtained after the ingestion of 100 grams of glucose at a single dose. Glycosuria expressed in terms of percentage or output of sugar in twenty-four hours is unreliable, since disease of the kidneys may have advanced to such a degree that no sugar is excreted by the kidney cells into the urine, even though the blood sugar concentration may be more than twice that which is normal and diabetes is thus present without glycosuria. As stated before, the cause of death in seventy per cent. of diabetics who were operated upon was acidosis and coma, therefore, it would seem to be of the utmost importance that we have information regarding the severity of the diabetes mellitus if possible on all diabetic subjects about to be operated upon, before the operation is performed. One of the most reliable tests for determining the degree of acidosis present, is the CO_2 combining power of the blood. This is not a difficult procedure. Normal blood shows a CO_2 combining power of fifty-five per cent. or more. Severe degrees of acidosis are present in those with a CO_2 combining power of twenty or less. Foster[15] states that to the best of his knowledge no diabetic with a CO_2 combining power less than thirty per cent. has successfully withstood a surgical operation. Diabetics with a normal CO_2 combining power blood, but with a high blood

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* One death was due to metastases and the other to pulmonary embolism.

sugar concentration (0.35 per cent. or more) may succumb to acidosis post-operatively. Foster[15] believes that one may say that patients showing hyperglycemia of 0.35 per cent. or more, or a CO_2 combining power of less than forty per cent. cannot be expected to survive a surgical operation. The only hope in these cases lies in changing their metabolic state prior to operation, if possible.

The object sought in the treatment of diabetics about to receive a surgical operation does not differ in principle from the recognized treatment. It is very obvious that the safety in surgery upon diabetics lies in preoperative care, if possible seeking to abolish acidosis and get the blood sugar percentage within normal limits. This is usually possible in all cases, except acute surgical emergencies, requiring immediate surgical intervention in which plans should promptly be laid to carry out an anti-acidosis program of treatment immediately following the operation.

Diabetics with arteriosclerosis are also bad risks and should have the preliminary treatment slowly carried out to restore the carbohydrate metabolism to as near normal as possible.

EXAMINATION OF THE URINE.

The chemical examination of the urine is the chief diagnostic means we have at hand to recognize early the existence of a glycosuria, whether or not it be diabetic in origin. It is important to recognize the presence of glycosuria by chemical tests before other symptoms accompanying it, and to accomplish this it would be highly desirable not only to make an examination of the urine of persons who are suspected of having the disease or those who are actually ill, but to educate the public to have a specimen of a twenty-four hour collection of urine examined at least once each year. Were this practice routinely carried out diseases which can be detected by urine examinations would be recognized at an earlier date.

It is desirable that all patients with diabetes mellitus know how to examine their urine chemically. This practice results in the greatest amount of good to the greatest number of individuals, and this fact alone more than fully meets the objections made by some physicians that it is undesirable to

teach patients to perform these tests. Of course, we must not entirely form or base our opinions on the patient's reports of the urinary findings, but the patients' results should be checked up daily, weekly and later monthly while under treatment.

Diabetic patients should be taught to examine the urine for the presence of sugar, to note the specific gravity of the urine, the reaction of urine and record the twenty-four hour output of urine.

It is important not to examine a specimen of a single voiding since in this manner the presence of sugar may be overlooked, especially if the glycosuria be intermittent in appearance and present only after the ingestion of a large meal, or during a period of mental stress or excitement.

Quantity of Urine Voided by a Diabetic Patient. In the majority of diabetic patients the quantity of urine voided in twenty-four hours, is increased in amount, and usually the greater the percentage of sugar the greater the amount of urine. A diabetic patient under treatment usually shows a diminution in the quantity of urine coincident with the diminution in the quantity of sugar until the sugar is absent when the patient again voids the normal amount of urine for the twenty-four hour period.

The exceptions to the rule that a diminution in the quantity of urine is an indication of improvement, are if acidosis becomes manifest, and in the presence of renal disease in which the kidney's function is impaired.

It is important to bear in mind that sugar may be present in the urine and the amount of urine not increased in amount. The fact that the urine is normal in amount is, therefore, no excuse for not examining for the presence of sugar. Associated with the increased output of urine is also usually an increased frequency of urination, so that increased frequency of urination should always suggest glycosuria as a possible cause.

The Collection and Preservation of the Urine. The twenty-four hour specimen should be collected preferably from an hour on one day to the same hour on the following day, preferably beginning at 7 A.M. or 8 A.M. It is most important to collect the urine in a clean bottle previously boiled. The urine is preserved by keeping the bottle in a cool place since a number

of chemicals if added as preservatives in themselves are reducing agents and therefore may give positive tests for sugar. If the urine is allowed to undergo fermentation, small quantities of sugar present ·may be lost and consequently no evidence of the presence of the sugar is obtained by the usual test. .

Specific Gravity. As a general rule sugar increases the specific gravity above 1.020 but sugar may be present in urines with a specific gravity of 1.008 and upward.

The Physical Appearance of Diabetic Urine. The urine of an untreated diabetic is usually turbid and nearly colorless. It froths very readily upon shaking and gas bubbles are often present on standing.

TEST FOR GLUCOSE IN THE URINE.

Probably the best test solution with the least number of fallacies is Benedict's. Many other solutions are in common use and give satisfactory results such as Fehling's solution, Haynes, Nylander's, etc.

Fehling's solution has long been the standard solution used to determine the presence of sugar, but two solutions are required to be kept on hand, and it deteriorates upon long standing.

Benedict's Solution is largely free from the objections to the use of Fehling's solution and is made as follows:

To Make Benedict's Solution:

	Grams or c.c.
Copper sulphate	17.3
Sodium citrate	173.0
Sodium carbonate (anhydrous)	100.0
Distilled water sufficient quantity to make	1000.0

The citrate and carbonate of soda are dissolved with the aid of heat in 800 c.c. of distilled water. Filter if necessary into a glass graduate and add water sufficient to restore any quantity lost by filtration. Dissolve the copper sulphate in 100 c.c. of water. Pour the carbonate citrate solution in a large glass container and add the copper sulphate solution slowly with constant stirring and add water sufficient to make 1000 c.c. The solution is ready for use and keeps almost indefinitely.

In making the test place 5 c.c. of Benedict's solution in a test tube and add 8 drops of urine. Boil the mixture vigorously for three minutes and then allow the mixture to cool spontaneously. Do not hasten cooling by cold water or ice. If glucose is present the entire body of the solution will be filled with a precipitate which may be of a greenish, yellowish or reddish tinge, according to whether the amount of sugar is slight or considerable.

The Fermentation Test has been used to identify and ascertain the percentage of glucose in the urine. The test is performed by adding one-fourth cake of compressed yeast cake, thoroughly triturating with 100 c.c. of urine until a homogeneous mixture results. The mixture is placed in a saccharometer, kept in a warm place (85° to 90° F.) for twenty-four hours, and then a reading made which will, if fermentation has taken place, indicate the percentage of glucose that has fermented. It is necessary to test the mixture at the end of reading with Benedict's solution to note if the glucose present has been entirely fermented. It is also well to run a control of urine alone. Fill the saccharometer with the urine, keep at same temperature and note if fermentation takes place in the absence of yeast.

Another method of performing the fermentation test is to thoroughly triturate 100 c.c. of urine of a known specific gravity with about one-fourth cake of fresh yeast. Keep mixture at a temperature of 85° to 95° F. At end of twenty-four hours test with Benedict's solution to determine if fermentation is complete. After fermentation is complete the mixture is placed in a room of ordinary room temperature, at the end of one hour the specific gravity is again taken. The difference in specific gravity of the urine before and after fermentation multiplied by 0.23 gives the percentage of sugar present. The urine if alkaline before fermentation is begun should be acidified by the addition of a few crystals of tartaric acid.

The polariscope may be used to determine the percentage of glucose in a specimen of urine. A special form of polariscope has been devised for the examination of solutions containing sugar, and furnishes a ready and fairly accurate method for the quantitative estimation of sugar.

BLOOD SUGAR.

Various observers have stated that the percentage of sugar in the blood of normal individuals ranges from 0.08 per cent. to 0.14 per cent., with the average findings in the post absorptive period (the blood should be taken for examination before breakfast) of about 0.10 per cent. After a meal which is especially high in carbohydrate content there is usually a rise in the sugar content of the blood which may be sufficient to cause an overflow from the blood into the urine. If the carbohydrate is in a very assimilable form the body is unable to store it rapidly enough in the liver and muscles and therefore in order that an equilibrium should be rapidly restored in the blood the excessive glucose in the blood is unloaded by the kidney excretion. Equal amounts of more slowly assimilable forms of carbohydrate may be stored or utilized by the body in a greater percentage and consequently less or no glycosuria results.

The various glycosurias, except renal, phlorizin and uranium, are accompanied by hyperglycemia. In diabetic glycosuria, the blood sugar content varies from 0.20 per cent. to 0.40 per cent. in the average case. Joslin[1] records a patient with a blood sugar of 1.49 per cent. determined by Bang's method twelve hours before death. In mild cases of diabetes the hyperglycemia is seldom in excess of 0.2 to 0.3 per cent. By the term threshold point is meant the percentage concentration of sugar in the blood at which glycosuria results. The normal point or threshold at which sugar passes from the blood through the kidneys into the urine is about 0.16 to 0.18 per cent. As a general rule in uncomplicated diabetes there is a direct relationship between the degree of hyperglycemia and glycosuria. *i.e.* the greater the hyperglycemia, the greater the glycosuria. This, of course, is dependent upon normally active kidneys. Hyperglycemia may exist in conditions other than in diabetes, such as in nephritis, chronic arthritis, tabes and hyperthyroidism. Friedenwald and Grove[16] showed that cancer of the stomach* can be distinguished from other parts of the body and other diseases of the stomach by the presence of a higher blood sugar curve than normal. They

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* The writer also recently obtained high blood sugar curves in two cases.

found that after the administration of a single dose of 100 grams of glucose by mouth that in seventy-two out of seventy-five cases blood sugar curves higher than normal were obtained. Normally the blood sugar variation should conform to and be determined as follows:

1. Before breakfast, the patient not having taken any food since the evening meal the night before, a specimen of blood is taken for the determination of the percentage of sugar. Normally this percentage will be found to vary from 0.06 to 0.12 per cent.

2. Then 100 grams of glucose should be given in one dose by mouth.

3. The blood sugar should be determined one hour after the ingestion of the glucose, and normally from 0.12 to 0.18 per cent. represents the peak of the curve which should be obtained at this time.

4. At the end of two to two and one-half hours the blood sugar percentage should return to the normal percentage.

5. Deviations from the above percentages and periods of time are abnormal.

Sugar tolerance tests as measured by blood sugar percentages have a very definite value in determining potential diabetics and furnish an additional amount of evidence in all suspected disorders of carbohydrate metabolism.

A word of warning is necessary as to condemning all persons with abnormal blood sugar curves to the group of potential diabetics, as abnormally low sugar tolerance tests have already been reported in chronic arthritis, cancer of the stomach, and hyperthyroidism. Sherill[17] has reported that as the result of his observations he has noted that in the presence of a distinct hyperglycemia after mixed meals and when after the ingestion of 100 grams of glucose the blood sugar curve obtained exceeds the normal both in height and duration a definite diagnosis of diabetes is afforded. Of course this diagnosis is only made after all conditions other than diabetes, capable of producing this type of curve, have been eliminated, and when the type curve obtained on repetition is identical.

In diabetes complicated with nephritis, as in a number of cases of uncomplicated nephritis, the blood sugar content may be in no way related to the percentage of sugar in the urine.

The diseased kidney requires a higher concentration of the sugar content of the blood, than would be required by the same kidney if normal, before glycosuria results. The "threshold" is higher in nephritis and indeed it is possible to have an abnormally high blood sugar curve with no glycosuria due to disease of the renal cells.

Hypoglycemia is associated with endocrine disturbance and the carbohydrate tolerance of the patient is increased. In patients with diabetes who are doing poorly in spite of treatment, blood sugar may change from a high to a low hypoglycemia which often predicts a fatal termination.

It would seem, therefore, that the most reliable guide we have in the recognition of the severity of the condition and of the progress we are making is the fullest knowledge of our blood sugar concentration at every stage in the treatment of a diabetic patient. It is far more important than the similar knowledge of the sugar in the urine, since the latter is dependent on the former, and they are by no means in all cases proportionate to one another, for example as when the threshold point is raised in diabetes with chronic interstitial nephritis.

Slight muscular exercise results at times in an increase of blood sugar whereas more severe exercise may cause a lower blood sugar. These changes are only very temporary and adjust themselves to normal very promptly following the exercise.

During acute infections, especially in diabetics the sugar content of the blood may increase. Fever increases, or at times decreases the percentage of blood sugar. Dyspnea, emotional conditions, diseases of the liver, of the intestines, of the stomach and of the blood influence the blood sugar concentration.

Estimation of Blood Sugar.

Since in the recognition and treatment of diabetes mellitus, a very important factor is a knowledge of the percentage of the blood sugar under various conditions, it is equally important that the methods used to obtain these facts are most reliable.

The several essential qualifications that any method selected for testing the blood for its sugar percentages are that it be accurate, very readily and simply performed, and that a minimum amount of blood be required. Lewis and Benedict were among the first to introduce a satisfactory, not too complicated, yet accurate method to determine the percentage of blood sugar. The principle of the test is that glucose, picric acid, and sodium carbonate react to produce a red color, sodium picrinate which in turn can be compared colorimetrically with a standard glucose, picric acid and sodium carbonate solution. Picric acid not only serves as essential to develop the red color but also acts by removing the protein from the blood, which is an essential step in the performance of the test. Myers and Bailey[18] have further simplified the technic of Lewis and Benedict by a lower dilution of the blood, so that the direct picric acid filtrate may at once be used for colorimetric determination without the process of evaporation. Myers[19] mentions the following methods that may be employed, and quotes Host and Hatlehol[20] who have presented some interesting comparative data on the methods of (1) Bang and Hatlehol, Bang's[21] most recent method; of (2) Hagedorn and Jensen[22]; of the Myers-Bailey[18] modification of the Lewis-Benedict method; and of the method of Folin and Wu.[23] The first two methods which are titrametric in principle agree very closely but give lower results than the second two which are colorimetric. Another method is a new titration method of MacLean.[24]

Methods. Blood is drawn from a prominent vein in the forearm in the usual manner into a test tube containing 0.02 grams powdered potassium oxalate per 10 c.c. of blood to prevent clotting. Blood specimens (Hawk[25]) are best taken in the morning before breakfast to minimize the influence of food ingestion. Specimens should be kept in the ice box and analyses preferably made on the day of withdrawal. This is particularly necessary in the case of sugar, which decreases in amount on standing. Denis[26] has shown, however, that at least for the Folin and Wu sugar method blood may be preserved for four days or more at 20-33° C., if one drop ($\frac{1}{30}$ c.c.) of commercial formalin (40 per cent.) solution is added to each 5 c.c. of blood.

Benedict's[27] **Modification of the Method of Lewis and Benedict.**[28]   *Procedure.*   Two c.c. of blood are aspirated through a hypodermic needle and a piece of rubber tubing into an Ostwald pipette, a little powdered potassium oxalate in the tip of the pipette preventing clotting. (It may be more convenient to draw about 5 c.c. of blood directly into a test-tube containing a little finely powdered potassium oxalate and removing 2 c.c. portions of this with the Ostwald pipette). The blood is drawn up a little above the mark and the end of the pipette is closed with the finger. After the rubber tubing and needle are disconnected, the blood is allowed to flow back to the mark and is discharged at once into a 25 c.c. volumetric flask, or into a large test-tube graduated at 12.5 c.c. and 25 c.c. The pipette is twice rinsed with distilled water, these washings being added to the blood. The contents of the flask are shaken to insure thorough mixing and a consequent laking or hemolysis of the blood, which is practically complete after a minute or two. A solution of sodium picrate and picric acid (to prepare the picrate-picric acid solution: place 36 gm. of dry powdered picric acid in a liter flask or stoppered cylinder, add 500 c.c. of 1 per cent. sodium hydroxide solution, and 400 c.c. of hot water. Shake occasionally until dissolved. Cool and dilute to 1 liter) is added to the 25 c.c. mark (using a few drops of alcohol to dispel foam if necessary) and the mixture thoroughly shaken. After a minute or two (or longer) the mixture is poured upon a dry filter, and the clear filtrate collected in a dry beaker. Exactly 8 c.c. of the filtrate are measured into a large test-tube bearing graduations at the 12.5 c.c. and 25 cc. mark, and 1 c.c. of 20 per cent. (anhydrous) sodium carbonate solution is added. The tube is plugged with cotton and immersed in boiling water for 10 minutes. (Longer heating up to half an hour makes no change in the color.) It is then removed, and the contents are cooled under running water and diluted to 12.5 c.c. or to 25 c.c. depending on the depth of color. (Occasionally the final filtrates in this or other picric acid methods develop a little turbidity during heating. Unless such turbidity is fairly marked it is of no account. When desired, the final colored solution may be filtered through a small folded filter into the colorimeter cup.) At any time

within a half an hour the colored solution is compared in a colorimeter with a suitable standard solution, the standard being set at a height of 15 mm.

The standard solution may be simultaneously prepared from pure glucose by treating 0.64 mg. of glucose in 4 c.c. of water with 4 c.c. of the picrate-picric acid solution and 1 c.c. of the carbonate, and heating for 10 minutes in boiling water and then diluting to 12.5 c.c. A permanent standard solution may be prepared from picramic acid or from potassium dichromate as mentioned below. Permanent Standard—The picramic acid standard is best prepared from a stock solution containing 100 mg. of picramic acid and 200 mg. of sodium carbonate per liter. One hundred twenty-six c.c. of this solution are treated with 1 c.c. of the 20 per cent. sodium carbonate solution and 15 c.c. of the picrate-picric acid solution, and diluted to 300 c.c. with distilled water. This solution matches exactly the color obtained by treating 0.64 mg. of glucose, as in the above method and diluting to 12.5 c.c. A satisfactory preparation of picramic acid may be obtained from the J. T. Baker Chemical Co. (Phillipsburg, N. J.). The potassium dichromate standard does not match the unknown with absolute exactness, but can be employed with satisfactory results when pure picramic acid is not obtainable.

Calculation. If directions are followed exactly the calculation is as follows:

$$\frac{\text{Reading of standard}}{\text{Reading of unknown}} \div 10 = \text{per cent. of sugar in the original blood.}$$

Where the final dilution of the unknown is made to 25 c.c. instead of 12.5 c.c. the final figure is, of course, multiplied by two.

Blood Analysis System of Folin and Wu.[23] This method offers a means of estimating the sugar content, non-protein, nitrogen, urea, uric acid, creatinine and creatine on a single blood specimen which frequently is very desirable. The first step is to prepare the protein free blood filtrate as follows:

Principle. The total proteins of the blood are removed by precipitation with tungstic acid (formed by the interaction of sodium tungstate and sulphuric acid) and filtration. The fil-

trate contains all of the constituents of the blood determined by this system.

Procedure. To prevent coagulation 20 mgs. of potassium oxalate per 10 c.c. of blood should have been used. Use of much larger amounts of oxalate or the use of citrate interferes with deproteinization, and interferes more or less with the uric acid determination.

Transfer a measured quantity (5 to 15 c.c.) of oxalated blood to a flask having a capacity of fifteen to twenty times that of the volume taken. Lake the blood with seven volumes of water. Add one volume of 10 per cent. solution of sodium tungstate ($Na_2Wo_42H_2O$) and mix. Some sodium tungstates, though labeled C. P., are not serviceable for this work. They usually contain too much sodium carbonate. The C. P. sodium tungstate made by the Primos Chemical Company, Primos, Pa., is satisfactory.

Add from a graduated pipette or burette, slowly and with shaking one volume of two-thirds normal sulphuric acid. (A two-thirds normal sulphuric acid solution, 35 g. of concentrated C.P. sulphuric acid diluted to a volume of 1 liter, will usually be found to be correct; but it is advisable, indeed necessary, to check it up by titration. The two-thirds normal acid is intended to be equivalent to the sodium content of the tungstate so that when equal volumes are mixed substantially the whole of the tungstic acid is set free without the presence of an excess of sulphuric acid. The tungstic acid set free is nearly quantitatively taken up by the proteins and the blood filtrates obtained are, therefore, only slightly acid to Congo red paper.) Close the mouth of the flask with a rubber stopper and shake. If the conditions are right, hardly a single air bubble will form as a result of the shaking. Let stand for 5 minutes; the color of the coagulum gradually changes from bright red to dark brown. If this change in color does not occur, the coagulation is incomplete, usually because too much oxalate is present. In such an emergency the sample may be saved by adding 10 per cent. sulphuric acid, one drop at a time, shaking vigorously after each drop, and continuing until there is practically no foaming and until the dark brown color has set in.

Pour the mixture on a filter large enough to hold it all. This filtration should be begun by adding only a few cubic centimeters of the mixture down the double portion of the filter paper and withholding the remainder until the whole filter has been wet. Then the whole of the mixture is poured on the funnel and covered with a watch glass. If the filtration is made as described the very first portion of the filtrate should be clear as water and no re-filtering is necessary.

It will be noted that the precipitation is not made in volumetric flasks. By the process described 6 or 7 or 11 or 12 c.c. of blood can be used, whereas with volumetric flasks one is compelled to use 5, 10 or 20 c.c., because flasks suitable for other volumes are not available. Special graduated "blood pipets," made by the Emil Greiner Co., New York, are very useful for the measurement of the blood, the tungstate and the acid.

The protein free blood filtrates are not acid enough to prevent bacterial decomposition. If the filtrates are to be kept for any length of time, more than two days, some preservative, a few drops of toluene or xylene should be added.

Determination of Sugar. *Principle.* The protein-free blood filtrate is heated with alkaline copper solution, using a special tube to prevent reoxidation. The cuprous oxide formed is treated with a molybdate phosphate solution, a blue color being obtained which is compared with that of a standard.

Procedure. Transfer two c.c. of the tungstic acid blood filtrate to a blood sugar test-tube (these test-tubes, with or without graduation, may be obtained from Emil Greiner, New York), and to two other similar test-tubes (graduated at 25 c.c.) add 2 c.c. of standard sugar solution containing respectively 0.2 and 0.4 mg. of glucose. Standard Sugar Solutions— Three standard sugar solutions should be on hand: (1) a stock solution, 1 per cent. glucose or invert sugar, preserved with xylene or toluene; (2) a solution containing 1 mg. of sugar per 10 c.c. (5 c.c. of stock solution diluted to 500 c.c.); (3) a solution containing 2 mg. of sugar per 10 c.c. (5 c.c. of the stock solution diluted to 250 c.c.). The invert sugar solution has the advantage that it can be easily prepared from cane sugar, which is pure. When good quality glucose is available, it is, of course the one to use. The diluted solu-

tions should be preserved with a little added toluene or xylene; it is probably better not to depend on such diluted solutions to keep for more than a month, but the stock solution should keep indefinitely. To each tube add 2 c.c. of the alkaline copper solution. Alkaline Copper Solution—Dissolve 40 gm. of pure anhydrous sodium carbonate in about 400 c.c. of water and transfer to a liter flask. Add 7.5 gm. of tartaric acid, and when the latter has dissolved add 4.5 gm. of crystallized copper sulphate. Mix and make up to a volume of 1 liter. If the chemicals used are not pure a sediment of cuprous oxide may form in the course of 1 or 2 weeks. If this should happen, remove the clear supernatant reagent with a siphon, or filter through a good quality filter paper. The reagent seems to keep indefinitely. To test for the absence of cuprous copper in the solution, transfer 2 c.c. to a test-tube and add 2 c.c. of the molybdate phosphate solution; the deep blue color of the copper should almost completely vanish. In order to forestall improper use of this reagent attention should be called to the fact that it contains extremely little alkali, 2 c.c. by titration (using the fading of the blue copper tartrate color as indicator, requiring only about 1.4 c.c. of normal acid.)

The surface of the mixture must now have reached the constricted part of the tube. If the bulb of the tube is too large for the volume (4 c.c.) a little, but not more than 0.5 c.c. of a diluted(1.1) alkaline copper solution may be added. If this does not suffice to bring the contents to the narrow part, the tube should be discarded. Test-tubes having so small a capacity that 4 c.c. fills them above the neck should also be discarded. Transfer the tubes to a boiling water bath and heat for 6 minutes. Then transfer them to a cold water bath and let cool without shaking for 2 or 3 minutes. Add to each test-tube 2 c.c. of the molybdate phosphate solution. Transfer to a liter beaker 35 gm. of molybdic acid and 5 gm. of sodium tungstate. Add 200 c.c. of 10 per cent. sodium hydroxide and 200 c.c. of water. Boil vigorously for 20 to 40 minutes so as to remove nearly the whole of the ammonia present in the molybdic acid. (The molybdic acid which may be obtained from the Primos Company, Primos, Pa., contains considerable ammonia.) Cool, dilute to about 350 c.c., and add 125 c.c. of concentrated (85 per cent.) phosphoric acid. Di-

lute to 500 c.c. The cuprous oxide dissolves rather slowly if the amount is large but the whole, up to the amount by 0.8 mg. of glucose, dissolves usually within 2 minutes. When the cuprous oxide is dissolved, dilute the resulting blue solutions to the 25 c.c. mark, insert a rubber stopper, and mix. It is essential that adequate attention be given to this mixing because the greater part of the blue color is formed in the bulb of the tube. Compare in a colorimeter using the standard which most nearly matches the unknown.

The two standards given representing 0.2 and 0.4 mg. of glucose are adequate for practically all cases. They cover the range from about 70 to nearly 400 mg. of glucose per 100 c.c. of blood.

It will be noted that in the process described cooling of the alkaline cuprous oxide suspension before adding the phosphate molybdate solution is suggested. This cooling is not essential and, in case of one or two determinations only, may be omitted. In a large series of determinations it is probably best to use it. The important point is that the standard and the unknowns should not only be heated the same length of time but should also have substantially the same temperature when the acid reagent is added. The maximum color develops faster in hot solutions; but if a reasonable uniformity of condition is maintained it makes no difference whether the color comparison is made at the end of five minutes or at the end of one hour.

Calculations $\dfrac{\text{Reading of standard}}{\text{Reading of unknown}} \times \dfrac{\text{mg. of glucose in standard}}{2} = \text{Grams}$
of glucose per 100 c.c. of blood.

Interpretation. Normal blood contains from 0.08 to 0.12 per cent. of glucose. In mild diabetes values of from 0.14 to 0.30 are obtained, and in severe diabetes values up to 1.2 per cent. Hyperglycemia is found also in nephritis and hyperthyroidism. Hypoglycemia has been noted in hypothyroidism, Addison's disease, muscular dystrophy, etc. Normally sugar begins to appear in the urine when the blood concentration reaches 0.15 to 0.18 per cent.

The concentration of sugar in the corpuscles is usually a little lower than in the plasma and more variable. Plasma determinations may therefore, possess some advantage over whole blood determinations. (Wishart.[29])

FAT CONTENT OF THE BLOOD IN DIABETES.

The fat content of the blood is increased in all grades of diabetes. The plasma in a moderately severe case of diabetes presents a milky appearance due to the fat. Normally 0.6 per cent. to 0.7 per cent. of total fat is found in the blood plasma. The cholestrol content of the blood is fairly constant when compared with the total fatty acids of this medium. Cholestrol is present in whole blood in a concentration of 0.14 per cent. to 0.17 per cent., with slightly higher values for blood plasma, 0.15 per cent. to 0.18 per cent. It has been found that a more marked hypercholesterolemia may be found in the lipemia of diabetes than any other condition. Joslin, Bloor and Gray[31] found that the average amount of lipoids in the blood in nineteen normal individuals was 0.59 per cent. as determined by the Bloor method. In thirty cases of mild diabetes it was increased to 0.83 per cent. and in thirty-seven moderately severe cases to 0.91 per cent. and 1.41 per cent in fifty-five cases of severe diabetes.

FOOD REQUIREMENTS.

THE NORMAL ADULT.

The diet of the average, normal individual, when discussed in the text-books, is usually spoken of in terms of calories. By a calorie is meant the amount of heat required to raise the temperature of one kilogram of water from zero to 1 degree centigrade. Foods are principally composed of carbohydrate, protein, fat, mineral substances, and water and to determine the caloric value of foods one must know their carbohydrate content, protein content and fat content.

One gram of carbohydrate produces 4.1 calories.
One   "   " protein   "   4.1   "
One   "   " fat   "   9.3   "

The caloric needs of the body vary greatly not only within the needs of every individual but also among different individuals. In a general way the average daily caloric needs of a moderately active individual can be expressed as follows:

400 grams of carbohydrate producing 1640 calories.
100   "   " protein   "   410   "
100   "   " fat   "   900   "
                        Total   2950

The error in estimating the amount of calories and food required may be considerable, and ofttimes cannot be done within twenty per cent. of what is accurate.

One, for instance, knows that the more active an individual is, the greater number of calories required, and that the greater the body weight the more calories required. According to Joslin[1] it has been estimated that an individual weighing 70 kilograms requires under different degrees of effort the average number of calories as follows:

| Condition | Calories required in twenty-four hours per | | Total calories |
	Kilogram of body wt.	Pound of body wt.	70 kilos = 154 pounds
At rest	25 — 30	11 — 14	1750 — 2100
Light work ...	35 — 40	16 — 18	2450 — 2800
Moderate work	40 — 45	18 — 20	2800 — 3150
Hard work	45 — 60	20 — 27	3150 — 4200

It is apparent that of the total calories needed carbohydrate must supply a big part. In regards to quantity two-thirds (400 grams) of the total number of grams of all foods, namely 600 grams, is carbohydrate. These 400 grams of carbohydrate furnish 1640 calories of heat of a total daily caloric need of 2950 calories. Carbohydrate metabolism disturbance is therefore a rather important disorder when viewed from this standpoint alone. While an average daily diet consisting of 400 grams of carbohydrate, 100 grams of protein and 100 grams of fat is considered necessary to keep in health the normal adult, nevertheless, we meet normal individuals who, because of custom, economic conditions or personal like or dislike alter this proportion considerably.

THE DIABETIC.

With the inability of the diabetic to utilize carbohydrate as efficiently as the normal individual, it is evident that the deficiency must be supplied by adjusting the body needs to the carbohydrate tolerance, and the addition of sufficient protein and fat to supply the minimum caloric needs which would be required by the individual under normal conditions. Even this can not always be accomplished at first, though later in the

course of the disease, if the urine has remained sugar free,
it may be possible to raise the caloric tolerance. One of the
reasons for the untreated or improperly treated diabetic losing
weight and strength is that with the loss of carbohydrate in
the urine, there is also a loss of many calories to the body
which would otherwise be available to keep up weight and a
supply of energy.

It is probably advisable to keep the average case of moder-
ately severe diabetes on a daily carbohydrate intake not greater
than 100 to 125 grams. This means a loss of approximately
1200 calories which would be yielded by 300 grams of carbohy-
drate, and, in order to make up the body loss of 1200 calories,
aproximately 129 grams of fat would have to be added to the
100 grams of fat normally taken. This is, however, never
done, but the total caloric intake is reduced and some of the
carbohydrate deficiency is made up by increasing the fat and
the protein to produce a nitrogen equilibrium. When fat
either disagrees with the patient's gastrointestinal tract or
causes acidosis the protein must be utilized so far as possible
to make up the caloric deficiency.

The physician who would today successfully treat diabetes
mellitus, and also many other diseases, must know something
about the kind of foodstuffs best adapted to the needs of
these diseases, the composition of this food and as a conse-
quence the caloric value. This information is printed in a
very readily accessible form in many books on diet.

BODY WEIGHT IN RELATION TO DIABETES, MELLITUS.

This is of sufficient importance to be considered separately
as a distinct phase of the subject of diabetes mellitus.

It will be remembered that probably sixty per cent. of all
diabetics give a history of having been overweight at some
time before they developed diabetes mellitus.

Patients are usually greatly alarmed at the rapid loss of
weight in diabetes and also the additional weight that is often
lost subsequent to the beginning of diabetic treatment. Some-
times this loss of weight is not great, or the patient may even
gain when on a semi-starvation diet, due to the ingestion of
large quantities of bicarbonate of soda or chloride of soda, as

HEIGHTS AND WEIGHTS OF 136,504 WOMEN OF TWENTY-FIVE OR MORE
YEARS OF AGE (WITH CLOTHES).

Graded Average Weight in Pounds with Clothes;
Feet and Inches with Shoes.

Age	4-8	4-9	4-10	4-11	5-0	5-1	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	6-0
25	109	111	113	115	117	119	121	124	128	131	135	139	143	147	151	154	158
26	110	112	114	116	118	120	122	125	128	131	135	139	143	147	151	155	159
27	110	112	114	116	118	120	122	125	129	132	136	140	144	148	152	155	159
28	111	113	115	117	119	121	123	126	130	133	137	141	145	149	153	156	160
29	111	113	115	117	119	121	123	126	130	133	137	141	145	149	153	156	160
30	112	114	116	118	120	122	124	127	131	134	138	142	146	150	154	157	161
31	113	115	117	119	121	123	125	128	132	135	139	143	147	151	154	157	161
32	113	115	117	119	121	123	125	128	132	136	140	144	148	152	155	158	162
33	114	116	118	120	122	124	126	129	133	137	141	145	149	153	156	159	162
34	115	117	119	121	123	125	127	130	134	138	142	146	150	154	157	160	163
35	115	117	119	121	123	125	127	130	134	138	142	146	150	154	157	160	163
36	116	118	120	122	124	126	128	131	135	139	143	147	151	155	158	161	164
37	116	118	120	122	124	126	129	132	136	140	144	148	152	156	159	162	165
38	117	119	121	123	125	127	130	133	137	141	145	149	153	157	160	163	166
39	118	120	122	124	126	128	131	134	138	142	146	150	154	158	161	164	167
40	119	121	123	125	127	129	132	135	138	142	146	150	154	158	161	164	167
41	120	122	124	126	128	130	133	136	139	143	147	151	155	159	162	165	168
42	120	122	124	126	128	130	133	136	139	143	147	151	155	159	162	166	169
43	121	123	125	127	129	131	134	137	140	144	148	152	156	160	163	167	170
44	122	124	126	128	130	132	135	138	141	145	149	153	157	161	164	168	171
45	122	124	126	128	130	132	135	138	141	145	149	153	157	161	164	168	171
46	123	145	127	129	131	133	136	139	142	146	150	154	158	162	165	169	172
47	123	125	127	129	131	133	136	139	142	146	151	155	159	163	166	170	173
48	124	126	128	130	132	134	137	140	143	147	152	156	160	164	167	171	174
49	124	126	128	130	132	134	137	140	143	147	152	156	161	165	168	172	175
50	125	127	129	131	133	135	138	141	144	148	152	156	161	165	169	173	176
51	125	127	129	131	133	135	138	141	144	148	152	157	162	166	170	174	177
52	125	127	129	131	133	135	138	141	144	148	152	157	162	166	170	174	177
53	125	127	129	131	133	135	138	141	144	148	152	157	162	166	170	174	177
54	125	127	129	131	133	135	138	141	144	148	153	158	163	167	171	174	177
55	125	127	129	131	133	135	138	141	144	148	153	158	163	167	171	174	177

Association of Life Insurance Directors and Actuarial Society of America,
New York, 1912, pp. 38 and 67. Published by a committee. Allow one and
one-half inches for shoes and six pounds for clothes.

both of these substances by remaining in the tissues retain
fluid and thereby maintain body weight. Under ordinary
conditions a diet high in carbohydrate will increase body
weight. The same number of calories, as furnished by carbo-
hydrate, given in the form of fats will not increase the weight,
in fact the weight may be lowered by the fat.

A patient's increase in weight is best when there is a de-
finite proportion maintained, as found in normal individuals,
between the amount of carbohydrate and fat of the diet. This
increase of weight is chiefly due to the ability of carbohydrate
to retain more fluid per given unit than either protein or fat.

A rapid loss in weight in a diabetic patient is often noticed just prior to or during coma.

A diabetic always can be considered to have the most acceptable weight when he is from 10 to 15 per cent. below the standard weight given for his age and height (see preceding and following tables).

HEIGHTS AND WEIGHTS OF 221,819 MEN OF TWENTY-FIVE OR MORE YEARS OF AGE (WITH CLOTHES).

Graded Average Weight in Pounds with Clothes; Feet and Inches with Shoes.

Age	5-0	5-1	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	6-0	6-1	6-2	6-3	6-4	6-5
25	122	124	126	129	133	137	141	145	149	153	157	162	167	173	179	184	189	194
26	123	125	127	130	134	138	142	146	150	154	158	163	168	174	180	186	191	196
27	124	126	128	131	134	138	142	146	150	154	158	163	169	175	181	187	192	197
28	125	127	129	132	135	139	143	147	151	155	159	164	170	176	182	188	193	198
29	126	128	130	133	136	140	144	148	152	156	160	165	171	177	183	189	194	199
30	126	128	130	133	136	140	144	148	152	156	161	166	172	178	184	190	196	201
31	127	129	131	134	137	141	145	149	153	157	162	167	173	179	185	191	197	202
32	127	129	131	134	137	141	145	149	154	158	163	168	174	180	186	192	198	203
33	127	129	131	134	137	141	145	149	154	159	164	169	175	181	187	193	199	204
34	128	130	132	135	138	142	146	150	155	160	165	170	176	182	188	194	200	206
35	128	130	132	135	138	142	146	150	155	160	165	170	176	182	189	195	201	207
36	129	131	133	136	139	143	147	151	156	161	166	171	177	183	190	196	202	208
37	129	131	133	136	140	144	148	152	157	162	167	172	178	184	191	197	202	209
38	130	132	134	137	140	144	148	152	157	162	167	173	179	185	192	198	204	210
39	130	132	134	137	140	144	148	152	157	162	167	173	179	185	192	199	205	211
40	131	133	135	138	141	145	149	153	158	163	168	174	180	186	193	200	206	212
41	131	133	135	138	141	145	149	153	158	163	168	174	180	186	193	200	207	213
42	132	134	136	139	142	146	150	154	159	164	169	175	181	187	194	201	208	214
43	132	134	136	139	142	146	150	154	159	164	169	175	181	187	194	201	208	214
44	133	135	137	140	143	147	151	155	160	165	170	176	182	188	195	202	209	215
45	133	135	137	140	143	147	151	155	160	165	170	176	182	188	195	202	209	215
46	134	136	138	141	144	148	152	156	161	166	171	177	183	189	196	203	210	216
47	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217
48	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217
49	134	136	138	141	144	148	152	156	161	166	171	177	133	190	197	204	211	217
50	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217
51	135	137	139	142	145	149	153	157	162	167	172	178	184	191	198	205	212	218
52	135	137	139	142	145	149	153	157	162	167	172	178	184	191	198	205	212	218
53	135	137	139	142	145	149	153	157	192	167	172	178	184	191	198	205	212	218
54	135	137	139	142	145	149	153	158	163	168	173	178	184	191	198	205	212	219
55	135	137	139	142	145	149	153	158	163	168	173	178	184	191	198	205	212	219

TREATMENT.

A thorough knowledge of the many factors which enter into the proper treatment of diabetes mellitus according to present day methods, is equal in importance to the early

recognition of the disease. The treatment is made much easier and the results to be expected are much better, the earlier the condition is recognized. Even more important than the early diagnosis is the prevention of the disease in those individuals predisposed. The treatment should always have for its object, making the patient feel better after undergoing it, than before.

PROPHYLACTIC.

In reviewing the histories of patients suffering from diabetes mellitus one cannot help but be impressed with the frequency with which there is present a familial or hereditary tendency. A child may show the disease before a parent develops symptoms. This is largely due to conditions present in the child who, being a potential diabetic, manifests symptoms of the disease. Persons with a family or hereditary history of diabetes should have their urine examined frequently for sugar, avoid excesses at the table, prevent obesity by proper diet and exercise. Undue mental work, strain or worry, are factors which should be avoided because they may precipitate an attack of diabetes mellitus in those predisposed. Frequent vacations with mental relaxation should be sought by those with a predisposition to diabetes mellitus, together with plenty of outdoor exercise. During acute infectious diseases in those with a history favorable to diabetes mellitus the urine should be carefully watched and if necessary dietetic measures promptly instituted. It is well to reduce the caloric intake very materially if sugar appears in the urine.

The early recognition of diabetes mellitus is dependent on frequent urine examinations, or if a patient is in doubt, being of a diabetic family or with a hereditary tendency to the disease, much information can be gathered by subjecting the patient to a blood-sugar test following the ingestion of 100 grams of glucose, as described on page 727. In this manner an idea may be obtained as to the ability of the patient to handle carbohydrates.

The predisposing cause of the diabetes must always be sought for and removed entirely or as much as possible. Each patient should be thoroughly studied and his needs fully de-

termined as treatment proceeds. The diabetic requires to be thoroughly educated with regard to the etiology of the disease, its course, its dangers, its prognosis, and its treatment, the latter in detail in-so-far as it discloses to the patient the composition of food and its equivalent in calories.

DIETETIC.

The modern treatment which has given very satisfactory results is so largely dietetic that the physician must be generally informed upon the relative food values of the ordinary articles of diet. The information can be very readily obtained by devoting a little time in carefully noting precentage contents of the various commonly used foodstuffs which many text-books have so well grouped for practical use and application.

The treatment of diabetes mellitus must be continued to some degree throughout the patient's life. The best result thus far that can be hoped for in tuberculosis is "arrest" of the disease, and diabetes mellitus, under suitable treatment, is at best only "arrested." The result of diabetic treatment is measured by an estimation of the sugar content of the blood and the urine. In the former the blood sugar concentration should be within normal range and in the latter the urine should be sugar-free. The degree of improvement may also be measured by the freedom of symptoms and the general "better feeling" of the patient. Diabetes mellitus occurring in individuals is described as being mild, moderately severe, and severe, according to the symptomatology. This is a more or less arbitrary classification and is not necessarily a measure of the duration of the disease.

One would naturally suppose that the mild cases probably would yield very readily to treatment, the moderately severe, less promptly, and the severe cases would require very exacting and active prolonged treatment. This deduction is not true in the strict sense of the word. Severe cases often become free from sugar and disturbing symptoms very readily, while mild cases are not infrequently neglected alike by physicians and patients until they become a serious problem, and offer difficulties in the way of securing a diet of sufficient calories to satisfy the body needs.

Treatment of a Mild Case of Diabetes Mellitus. Many cases of this type occur in obese individuals, in middle life and in those having a family or hereditary history of diabetes. Not infrequently a reduction in the total caloric intake of food in a twenty-four hour period results in the disappearance of symptoms with a disappearance of the glycosuria. Often associated with glycosuria in these mild cases are some of the complications of diabetes mellitus, such as neuritis, pruritus and indigestion, rather than the cardinal symptoms. When the urine becomes sugar-free these symptoms disappear very promptly. In the mild cases omission of the fat or a marked reduction in its consumption, with a very limited use or entire removal of foodstuffs high in glucose content (*i.e.,* sugar, bread, pastry), the sugar disappears. The patient may readily tolerate 100 grams or more of carbohydrate in a twenty-four hour period, but this amount is usually kept at less than 200 grams although the patient is able to tolerate larger quantities. Again it is most important not to dismiss the patients with too slight a warning as to what their future course must be. The importance of following the prescribed diet must be emphasized, the neglect of which may result in a more severe form of diabetes with one or more of the complications.

Treatment of moderately severe and severe cases of diabetes mellitus is based upon the following principles:

(1) Rendering the patient sugar-free.
(2) Determination of carbohydrate tolerance.
(3) Determination of protein tolerance.
(4) Determination of fat tolerance.
(5) Subsequent dietetic management.
(6) Preventing acid poisoning.

Rendering the patient's urine sugar-free is accomplished by fasting the patient or by greatly reducing his food intake, in the order of: first, fat; second, protein, and third, carbohydrate. By fasting is meant forbidding all substances by mouth except coffee, tea, broth, water, or an infusion of cracked cocoa or cocoa shells. In patients with diabetes mellitus of long duration, in the weakly or in the obese, sudden fasting may possibly cause acidosis. Rather than a sudden reduction of the diet to nothing but broth, tea and coffee,

it is usually more desirable to slowly reduce the diet, on the first day prohibiting the ingestion of all fat, the second and third days in addition to the removal of fat from the diet to reduce the protein intake ordinarily consumed, to one-half the amount. On the fourth day forbid all food except carbohydrate, which is reduced to one-half the amount ordinarily taken and on the fifth day nothing but broth, tea or coffee, if the urine has not been already rendered sugar-free. The patients usually need not to be kept in bed, but it is better that they be kept in a room with facilities for reclining. If after four days of fasting glycosuria persists, feeding had better be begun in the form of five per cent. vegetables, thirty to forty grams of carbohydrate being given daily, with one-half to one gram of protein per kilogram of body weight in twenty-four hours, continuing this diet for two days and again begin fasting on the third day.

Fasting usually is undertaken by the patients with some doubt on their part as to its value, but the first twenty-four or forty-eight hours, especially in the diabetics with distressing symptoms, convinces them that it is of the greatest benefit. The first day of fasting is usually the worst, the second day of fasting is more easily borne, and on the third day the patient usually feels better than he did before the fasting was begun.

Much can be done to lessen the apprehension of the diabetic during the fast by providing for some diversion, such as visits from friends, games, sewing, knitting, light reading, and if the weather permits, automobile riding.

Within the past nine months the writer has had under his care a man thirty-two years of age, whose brother died several years ago of diabetes mellitus. In spite of excellent medical advice and treatment the patient's brother refused to follow his diet and died in coma. The deceased man's brother, at that time, was not an active diabetic, but within two years showed a glycosuria with increased frequency of urination as the only other symptom. The patient had a good knowledge of diabetes mellitus as the result of being constantly associated with his brother during his illness. When fasting was suggested the patient readily agreed but stated it would be impossible to discontinue his work as a traveling salesman.

He carried on his fast, with but slight fatigue at the end of the day, for a period of three days, at the end of which the urine of the patient was sugar-free and the blood sugar—which before treatment was 0.22 per cent.—had returned to 0.12 per cent., without the loss of a day from his work. His diet was entirely readjusted and the urine of the patient is now sugar-free with a normal blood sugar percentage.

Fasting usually causes a disappearance of the tired, heavy, dull feeling complained of by diabetics, and if present, headache often is relieved. Thirst and frequency of urination are alleviated.

As a general rule fasting causes the disappearance of acidosis, if it be present at the time treatment is begun. It is safer, however, to proceed slowly in the preparation for the fast because it is the occasional patient who shows or rather develops acidosis upon the institution of fasting or during the preparation for the same. Therefore, it is far better to take four or five days to slowly reduce the diet than to institute the fast abruptly and as a result have acidosis develop.

It is not uncommon to find a patient with glycosuria and a mild degree of acidosis, especially if the disease is of long duration or in the aged, in which anything but a very slowly wrought change in the diet results in the development of acidosis, or causes the patient to be less comfortable than before the change of diet. The elderly patients frequently suffer more distress from the institution of a change in their diet than they do by the continuance of their former diet even though glycosuria be present. Of course one should make sure that the proper change in diet has been prescribed, rather than feel satisfied that the diet which has been selected (which may not have been the one indicated) is the cause of the unfavorable results.

In these long standing cases of diabetes mellitus with no bad results evident as the result of a mild degree of acidosis, the danger lurks in the lack of the factor of safety should other complications develop.

Fat is the recognized source of danger in those individuals predisposed to acidosis. The diabetic individuals, exposed to the danger of developing acidosis by the sudden reduction in the carbohydrate without any marked reduction in the fat

and protein, are: the obese; those in which the disease is of long duration; and those complicated with renal, cardiac or pulmonary disease. Feeble patients and those presenting a rapid progressive downward course of the disease must be properly prepared dietetically for the fast.

In the past the accepted treatment for diabetes was to suddenly reduce the carbohydrate in the diet to a minimum or even forbid the ingestion of carbohydrate in any form with an increase in fat and protein to compensate for the loss of calories by the elimination of carbohydrate from the diet. The results frequently were gastrointestinal disturbances, nausea, vomiting, constipation, and diarrhea; acidosis, and coma. With the elimination of fat, the reduction of protein and carbohydrate, in the order named, the gastrointestinal symptoms are usually relieved and acidosis disappears if present, or is prevented if there be tendency to its development.

The day or days of fasting are occupied by taking an abundance of fluids, preferably warm, such as broth, tea or coffee. The absence of solid food results in lack of oxidative processes taking place in the body, and warm drinks act as stimulants and supply body heat.

With fasting the patient's thirst becomes very much less and unless instructed the patient may neglect to drink a sufficient quantity of fluid. The output of urine during the fast should not be less than 1500 cubic centimeters in twenty-four hours. Loss of weight during the fast usually is not more than three to five pounds unless the patient has lost little weight prior to the institution of this measure. Salt in the broth will help keep up or increase the weight during the fast and its prohibition will result in an additional loss of weight and add to the unpleasantness of the procedure.

If the patient's intake of salt is excessive, edema—especially of the eyelids and feet—may result, doubtlessly due to salt retention. This usually clears up very promptly after the patient becomes sugar free and the diet is increased with a decrease in salt intake. An objection that must frequently be met in suggesting a fast to a diabetic is that it will result in a greater loss of weight than the patient believes he will be able to endure, having already lost considerable weight due to his diabetes. An abundance of salt during the several

days of the fast will often prevent any loss and even may result in a gain in weight.

During the fast the patient should be kept from exposure to contagion.

DETERMINATION OF TOLERANCE.

Carbohydrate. After a twenty-four hour specimen of urine has become sugar-free the next step is to determine the tolerance of the patient for carbohydrate. This is accomplished by giving food with bulk in order to satisfy the patient's appetite and with a low carbohydrate content, so that if an error is made in giving an excess in the determination of carbohydrate tolerance, it will not be as serious as if a food high in carbohydrate content were given.

Usually in the severe or moderately severe cases of diabetes, so-called according to the symptoms present, the patient on the first day is given from five to ten grams of carbohydrate in the form of five per cent. vegetables (the five per cent. referring to the carbohydrate content) distributed throughout the three meals, continuing the tea, coffee, water, broth or infusion of cocoa shells. So long as no sugar appears in the urine the carbohydrate is increased by five grams a day until the patient is taking about fifty grams or more in twenty-four hours, unless sugar appears in the urine before this amount is reached. When sugar appears in the urine the amount of carbohydrate ingested is noted and the patient is again fasted until the urine is sugar-free. Vegetables of higher carbohydrate content can be used if the patient will be satisfied with less bulk. Some of the fruits of low carbohydrate content can be substituted for vegetables, such as the orange and the grapefruit. Although the vegetables are classified according to five per cent. carbohydrate content, probably the average of the group is never greater than three per cent., and especially if the vegetables are twice or thrice boiled.* If the urine of the patient remains

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* Thrice or twice cooked vegetables. When vegetables are cooked in two or three changes of water there is a very material reduction in the carbohydrate content. This is accomplished by pouring off the water after the vegetables have begun to boil, adding water and boiling again, repeating once or twice. In this way bulk is given with a minimum carbohydrate content.

sugar-free for months during this period, as a general rule the patient's carbohydrate tolerance increases. A patient, even if his tolerance should be greater, is seldom given more than three grams of carbohydrate per kilogram of his body weight.

Protein. After the patient's urine shows sugar the amount of carbohydrate necessary to produce glycosuria is noted and the patient is fasted until the urine again becomes sugar-free, then two-thirds or three-fourths of the amount of the carbohydrate necessary to produce glycosuria is fixed as the carbohydrate tolerance. This amount of carbohydrate is given with the addition of fifteen grams of protein, and the protein increased fifteen grams daily until the patient is receiving from one to one and one-half grams per kilogram of body weight in the twenty-four hour period. Usually the white of egg, lean meat, or fish, is the form in which the protein is given. The protein tolerance can also be determined with the carbohydrate tolerance simultaneously by beginning with five to ten grams of carbohydrate on the first day with fifteen grams of protein, preferably as egg white. Then increase the carbohydrate five grams daily, and protein fifteen grams daily until the urine of the patient shows sugar. The amount of protein and of carbohydrate is then reduced by twenty-five per cent., and this will be the daily amount each of protein and carbohydrate to be used in the diet.

Fat. Means of determining the fat tolerance are not as satisfactory as those for determining the carbohydrate and protein tolerance. Several facts must be kept in mind regarding the amount of the fat taken. It is desirable to add sufficient fat to the patient's diet to maintain the patient's weight, or at least build up to slightly less than what the patient should weigh for his height and weight under normal conditions. This is not, however, always possible because the amount of fat necessary to bring the weight of the patient to this level will often produce sugar in the urine, either with or without acidosis. The fat content must be so balanced that the accumulation of acetone bodies is avoided. After the carbohydrate tolerance and protein tolerance have been established it is well to add ten grams of fat and increase the amount five to ten grams daily until the patient begins

to maintain his weight, which will usually be approximately two to three grams of fat for each kilogram of body weight.

The reason for the general rule of adding fat slowly is that one gram of fat yields nine calories of heat, whereas one gram of protein and one gram of carbohydrate yield respectively approximately four calories of heat. The rapid increase of fat would therefore result in a diet of greater caloric content than contemplated, because of this high yield of calories per gram as compared with the caloric yield per gram of carbohydrate and protein.

The slower the addition of the fat the less the danger of acidosis, and the slower the caloric content of the diet is increased the greater the amount of carbohydrate that will subsequently be tolerated.

In the majority of patients it is highly desirable to attain a maximum tolerance of carbohydrate not exceeding two hundred grams, with a tolerance for protein ranging from three-fourths gram to one and one-half grams per kilo of body weight and to make up the deficiency in caloric need with fat if the patient's total tolerance will permit. It has not been the experience of the writer, although cases have been reported, in which patients do better on a high fat-protein diet with a minimum amount of carbohydrate. In patients who are overweight or in whom it is desired to further reduce their weight, fat should be added slowly and in small quantities until the weight reduction sought is obtained.

Fat is usually prescribed to be taken, in the form of twenty per cent. cream or as butter, or in the form of egg, since the average egg contains six grams of fat. Olive oil is another substance suitable for supplying the body with fat. One ounce of twenty per cent. cream contains approximately six grams of fat with one gram carbohydrate and one gram of protein, thereby giving a maximum amount of fat with a minimum amount of carbohydrate and protein. Bacon likewise furnishes a suitable form in which fat may be taken, having a high fat content with a moderate protein content and no carbohydrate content. Butter supplies fat in an almost pure form, yielding twenty-five grams of fat in each thirty grams (one ounce) of butter. Olive oil yields thirty grams of fat to one ounce of oil. The foregoing furnishes

the articles of food in which the fat can best be calculated.
Meats have fat in their substance and an allowance for same
must be made in computing a diet.

Subsequent Dietetic Management.

The patient's urine, blood sugar concentration, and weight,
should be carefully watched after the diet which has been
determined upon for the patient is put into effect.

Daily examination of the urine for sugar should be made.
Blood sugar determinations should be made once a month.
The weight of the patient is recorded each week. The patient
is taught to collect all urine voided, measure it, and make an
examination for the presence of sugar. If it is not possible
to save the entire output of urine for twenty-four hours, the
urine voided within two hours immediately following the
principal meal of the day should be examined for sugar. The
necessity for examining the urine daily is that if the sugar
should appear it will be discovered very promptly. If sugar
appears it may not only be due to the fact that an error in
diet has been committed during that day, but that for days
there has been a gradual increase in food consumption asso-
ciated with or without a sufficient amount of exercise.

Immediately upon the discovery of sugar the patient be-
gins to fast and continues to do so until the sugar disappears.
The patient's urine again being sugar-free and he himself in
good physical condition, a gradual return to his former diet
may be made. This should, however, be done very slowly
and probably is best held at a point between eighty and ninety
per cent. of the former diet. Usually a fast of one day, in
patients who have been under treatment, causes the sugar
to disappear from the urine. The reappearance of sugar in
the urine means that the patient's total food tolerance has
been broken and calls again for a reëstablishment of this tol-
erance. While it is not desirable to deliberately cause a
patient to exceed his tolerance, it often has a very good effect
in those patients who constantly exceed the diet ordered for
them. These patients at times seek an opinion from their
physician, who, upon examining their blood sugar, their
urine, weight, and diet, remarks that the patient is doing
very well, whereupon the patient remarks, "I eat this or that

substance which you (the physician) prohibited, and yet you
say I am doing well. Why, then, can't I eat this substance
occasionally?" This type of individual is usually the one
who is greatly benefited by some morning discovering that
while on his usual diet sugar is present in the urine. This
sugar is due to accumulated violations of the diet list rather
than to a single indiscretion.

In view of the fact that sugar occasionally appears in the
urine of patients as the result of accumulated small violations
of the diet regulations, usually in the form of an increased
quantity rather than in taking that which is forbidden, it is
highly desirable to institute weekly fast days.

Weekly fast days are nothing new and were used by older
practitioners with excellent results. If the patient's carbo-
hydrate tolerance is low it is desirable, if the patient experi-
ences no great discomfort, to take only broth and liquids on
one day of each week. If the carbohydrate tolerance is high
—say, more than fifty grams of carbohydrate in twenty-four
hours—the diet ordinarily consumed may be halved. Some
patients do very well on "green days" or "oatmeal days," as
they were termed by the older clinicians. On the "green
days" only vegetables such as now fall in the five per cent.
carbohydrate class are taken, while on "oatmeal days" only
oatmeal is taken, which supplies to the body carbohydrate in
a slowly assimilable form and at the same time provides a
low caloric diet for the day. The fast days reduce the total
caloric intake at the expense, first, of restriction of fats;
second, the restriction of proteins, and, finally, of carbo-
hydrates.

Patients will do well to learn that which Joslin,[1] among
other things, teaches his diabetics, *viz.*, to serve themselves
with seventy-five grams of five per cent. vegetables, to keep
a record of the daily diet, and to state and record the quan-
tity of carbohydrate, protein and fat which it contains.
Patients should also learn how to prepare thrice cooked
(washed) vegetables, to prepare bran biscuits, to describe
what to do on weekly fast days and the means to be taken
if sugar appears in the urine. While traveling, patients
should know what to eat when the usual diet is not available.

If the patient has reason to suspect acid poison he should know what to do.

In diabetes, gain in weight beyond the standard figure of that of a normal individual is not always a good sign. In the early course of treatment for diabetes mellitus patients frequently state, "I am pleased to have gained so many pounds in the past week." It should be impressed upon the patients that fat diabetics must maintain a steady lower weight to do well and that all diabetics do better if they are kept on a caloric intake slightly below normal. Patients who return to their normal weight may also return to glycosuria.

Often following the rearrangement of the diet the patient will complain of diarrhea or constipation. Many patients on a diabetic diet will consume more vegetables than they had been accustomed to, which they may not masticate very thoroughly and diarrhea results. All food should be eaten slowly and thoroughly masticated.

Patients should be warned never to partake of any dish, whether or not it is recommended to diabetics, until they ascertain for themselves its composition. The so-called diabetic foods often are dangerous because of the large proportion of carbohydrate they contain, or, if they do not contain a large quantity of carbohydrate, because of their high protein or fat content, the caloric value is often too great.

A diabetic who does well is one who goes along slowly without trying to force his diet, keeping careful watch for glycosuria, and who very gradually increases his tolerance for carbohydrate, protein and fat, and gains in strength. The same diabetic will be one who works moderately, does not worry, takes outdoor exercise and sleeps eight to ten hours each night.

High Fat, Low Carbohydrate, Low Protein Diet.

The foregoing methods of treatment, based on the research work of Allen and his associates, are applicable to a large number of patients, with good results in most instances. It is estimated that the duration of life in the adult diabetic has been prolonged on an average of three years, by the dietary treatment described on the preceding pages. The results obtained in severe and progressive cases of diabetes on dietary

treatment, frequently leave much to be desired. No plan of dietetic treatment evolved thus far has restored the loss of weight and of strength in the advanced and progressive type of disease. Newburgh and Marsh,[31] in search for a diet that will yield better results than the plan described on the preceding pages, have developed a procedure which they believe will be an improvement over previous plans of diet, for the following reasons: (1) That glycosuria is avoided in severe diabetes; (2) that this diet does not precipitate acidosis; (3) that nitrogen equilibrium is maintained, and (4) that the patients are able to lead at least a moderately active life. This type has been referred to as the high fat, low protein and low carbohydrate diet. When the patient comes under this form of treatment a more or less routine plan is followed. He is promptly placed on a diet containing from 900 to 1000 calories, of which 90 grams is fat, 10 grams is protein and 14 grams is carbohydrate. After the patient's urine has been sugar-free for from one to two weeks, his diet is increased to about 1400 calories of which 140 grams is fat, 28 grams is protein, and from 15 to 20 grams is carbohydrate. In the case of small individuals this diet is sufficient and may be continued for some time. In the case of larger individuals another increase may be made to 1800 calories, containing 170 grams of fat, from 30 to 40 grams of protein, and from 25 to 30 grams of carbohydrate. Further additions up to twenty-five calories may be made to suit the individual case.

Newburgh[32] states that a diet of 900 calories chiefly derived from fat produces the same fall in basal metabolism as does starvation. It has advantages over starvation by being more successful in rendering the patient sugar-free, and is less dangerous. A low protein, low carbohydrate and high fat maintenance diet, fed a large group of diabetics since March 1, 1918, maintained an aglycosuric state, was not attended by acidosis; maintained nitrogen balance; did not cause hyperlipoidemia, and was attended by disappearance in those patients in whom it was present at the beginning of treatment; sufficient energy was supplied by this type of diet to avoid the evils of undernutrition; it permitted an amount of activity compatible with earning a livelihood, and within

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the limits of our observation was not attended by downward progress in uncomplicated cases.

Prior to the last decade, the dietary treatment that was most generally used was the low carbohydrate, high protein and high fat diet. The advantage of the Newburgh and Marsh diet over this diet is that these investigators reduce the protein content of their diet to meet the minimum requirements of the body, so as to secure a nitrogen equilibrium.

Marsh, Newburgh and Holly[33] reviewed the literature bearing on the minimum protein requirements of normal and diabetic patients which shows that the nitrogen balance in the diabetic is the same as that of the normal individual, provided the total calorie requirement is fulfilled. Two-thirds gram for each kilogram of body weight for a twenty-four hour period usually suffices, although it may be necessary to give up to one gram per kilogram of body weight.

Wilder[34] states that in the dietary treatment of diabetes, protein restriction is indicated for three reasons: (1) Because the ingestion of protein actually throws a large amount of sugar on the metabolism, 58 per cent. by weight of protein being convertible to glucose; (2) because the relatively high specific dynamic action of protein produces an undesirable elevation of the metabolic rate; and (3) because an excess of protein exerts a specifically depressant effect on the ability of the organism to utilize glucose.

It is well to remember that no one form of diet arrangement is applicable to all types of diabetes. No form of diet must be considered as better than another until sufficient time has elapsed, so that the subsequent course of the disease can be reviewed.

Finally, there are diabetics who do very much better on one type of diet than the other, for no clearly demonstrable cause. It is, therefore, well to be familiar with several forms of rational dietary measures that may be applied, should the initial diet prescribed not yield satisfactory results.

TREATMENT OTHER THAN DIETETIC.

Great stress has been laid upon the removal of possible sources of focal infection in diabetics, and placing the patients and maintaining them in the best possible physical condition.

The teeth should be carefully examined and treated if neces-
sary by a competent dentist, and an x-ray examination made of
every filled or crowned tooth.   If teeth need be extracted, the
operation should be performed under local anesthesia.   Brushing
the teeth after each meal, using an alkaline tooth powder, and the
use of dental floss are important factors in keeping the teeth in
first class condition.

The skin of a diabetic is very susceptible to infection and the
best and most prompt attention should be given to all injuries,
regardless of how slight the lesion.   Suppuration, even septicemia
or gangrene, may result from neglect of the early application of
proper treatment.   The skin should be thoroughly bathed daily.

Thorough evacuation of the bowels must be secured each day.
Usually the vegetables and the bran of the diabetic diet serve to
keep the bowels regular ; if not, mild laxatives can be used, such
as pills of cascara sagrada, or aloin, belladonna and strychnine
pills, or milk of magnesia.   Mineral oil often acts in a very
efficacious manner.   It is, however, more desirable to have the
bowels move naturally through the composition of the diet and
the effect of exercise, than to become a victim of the cathartic
habit.

Many drugs have been recommended in the treatment of dia-
betes, but none seem to have any direct good effect on the course
of diabetes mellitus, except possibly opium, the value of which
is very slight, not permanent and by no means to be compared with
the good results which proper diet gives.

Drugs are used in the treatment of symptoms, such as con-
stipation, for the relief of pain, as cardiac stimulants, etc.   Pro-
prietary preparations usually condemn themselves on their label,
which states that the drug will do this or that, which statement in
itself does not recognize the accepted etiology of diabetes mellitus.

Insulin (I'letin) Treatment.

Until the discovery of insulin, the dietary treatment, as des-
cribed in the preceding pages, was the best form of treatment, al-
though not satisfactory, especially in the severer types of diabetes.
The excellent results obtained by using insulin, with diets, bids
fair to replace and modify many of the older forms of diets.

Insulin, also known as I'letin, is an aqueous solution of the
active principle obtained from the islands of Langerhans in the

pancreas, which has been developed by Banting, Best and their co-workers at the University of Toronto, through their investigations which began in April, 1921. This extract, when injected subcutaneously, enables the diabetic patient to utilize carbohydrates in a normal manner. Since 1908 various attempts have been made to isolate the active agent in the pancreas having to do with sugar metabolism, which Banting and Best have now done for the first time successfully, and made available for the treatment of human diabetics. *Insulin is only an adjunct to the dietary treatment and in no way should result in a disregard of a diet regime.*

Although the value of insulin has been established, the best method for its use continues to be a matter of investigation and discussion. The major portion of insulin, thus far, has been used in cases of more or less severe diabetes and its complications, *viz.;* acidosis and diabetic coma. *According to our present information regarding insulin, it would seem that mild diabetics, whose pancreas can be made by dietetic treatment to secrete enough internal secretion, which we now call insulin, are not subjects in which insulin should be used.*

The plan of treatment followed in the severer types of diabetes is as follows, and should be conducted in a hospital, or where facilities exist for the necessary chemical examinations and preparation of the food.

After the patient is admitted to the hospital, the tolerance of the patient is determined as accurately as possible. This procedure is not essential but very desirable. It indicates the degree of severity of the diabetes, which is useful as a guide to the amount of insulin that will probably be required, and for a basis of comparison later in the course of the treatment.

During the first twenty-four hours the patient is maintained on a diet such as he had previous to his admission, to ascertain his twenty-four hour output of sugar and his blood sugar level. The patient is then placed on a diet containing the basal requirement, which is such that he is receiving about 30 calories per kilogram of body weight.

This diet must be so planned and balanced that the patient is receiving a sufficient number of calories to maintain his weight and supply the required energy for his body needs. First con-

sideration is given to the amount of protein food required. An adult needs not less than 0.7 to 0.8 gram of protein per kilogram of body weight, for example, a patient weighing 150 pounds (68 kilograms) would therefore require about 55 grams of protein in a twenty-four hour period. The amount of carbohydrate in this maintenance diet is arbitrarily fixed at one and one-half times the amount of protein, which in this case equals 83 grams. The amount of fat that will be oxidized completely to carbon dioxide and water must depend on the amount of available carbohydrate. It requires 1 gram of available carbohydrate to effect the complete combustion of 1.5 grams of fat.

It is a fact that at times fat may be given in excess of the ratio of 1.5 grams to 1 gram of available glucose without the development of ketonuria. This is especially true in very thin individuals who have very little fatty tissue. Fat stored does not enter into the metabolism of the body, therefore, as "fat stored" will not develop ketonuria.

In estimating the available carbohydrate in any diet, one must take into consideration that carbohydrate may be derived from protein to the extent of 58 per cent. of the total amount of protein. Therefore, the available carbohydrate amounts to 83 grams of carbohydrate prescribed as such, plus the 32 grams which may be derived from protein, or a total of 115 grams. One hundred and fifteen grams of carbohydrate will completely combust 173 grams of fat. The total calories furnished by this maintenance diet consisting of carbohydrate 83 grams, protein 55 grams, fat 173 grams, will be 2100 calories, equivalent to approximately 30 calories per kilogram, which is the normal requirement of an adult at rest.

In a severe diabetic, this diet would result in a marked glycosuria, until insulin is given in proper amounts which will readily control glycosuria and the percentage of blood sugar. The patient is maintained on this diet for about one week, until the excretion of sugar, if it has not disappeared from the urine, is at constant level. At the end of this period the administration of insulin is begun, to render the urine sugar free.

After sufficient insulin has been given subcutaneously to render the urine of the patient sugar free, and bring the blood sugar concentration within normal limits, the diet is slowly increased over a period of from six to eight weeks, at the

end of which time the patient is receiving from 600 to 800 calories above the maintenance diet. The carbohydrate, the protein and the fat are increased so that a normal balance is maintained between the ketogenic and the anti-ketogenic elements of the diet. With this increase in diet it is usually necessary to increase the dosage to prevent glycosuria and to keep the blood sugar percentage within normal range.

Very frequently the dosage of the insulin may be gradually reduced in amount since the pancreas may recover its ability to secrete additional insulin. Reduction of the dosage, however, is not always possible in patients with badly damaged islets of Langerhans.

The amount of insulin required to keep the patient sugar free and the blood sugar percentage normal, or slightly above, varies in different individuals.

It is not possible in the beginning to estimate the amount of insulin that will be required. It is safer to begin with small doses, certainly much smaller than would be expected. After the injection of insulin is begun in dosage of 1 to 5 units, given about one-half hour before meals, each specimen of urine voided should be examined for the presence of sugar. So long as glycosuria is present, there is no danger of hypoglycemia, but after glycosuria has disappeared, then the effects of insulin and its dosage must be controlled by blood sugar estimation. If the daily excretion of sugar is not diminishing, the dose of insulin must be increased slowly until glycosuria is controlled.

Each case is a law unto itself and considerable experimenting must be done in order to determine the amount of insulin which will be required to care for the diet, control the glycosuria and not produce hypoglycemia. It is safer to have a slight glycosuria and a slight increase in blood sugar than to be too close to hypoglycemia of 0.05 per cent. to 0.07 per cent. blood sugar. There is no fixed rule that will determine the amount of insulin required.

The subsequent dosage of insulin may have to be increased, more often decreased, to preserve ideal conditions. Patients not under constant supervision are safer with slight glycosuria than with normal blood sugar and no glycosuria, on account of the danger of the occurrence of hypoglycemia.

After a patient leaves the hospital it is usually possible to reduce the amount of insulin used, and the frequency of its administration. Patients, or members of their families, are readily taught to give the hypodermic injection of insulin. The frequency of injections given in the hospital may be reduced from three times daily to twice, or even once daily. In some of the patients, discontinuance of the injections for a twenty-four hour period once or twice a week has resulted in no harm. If glycosuria appeared it was readily controlled within twenty-four hours. The ideal condition to work for, is to reduce the frequency of, and the dosage so that finally the patient will not be taking any insulin, being able to supply his body needs and energy with the secretion from his pancreas. This is possible in some cases, just how many will remain to be seen.

The unit of insulin originally adopted was the amount required to lower the normal blood sugar of a 1 kilogram rabbit to 0.045 per cent., at which point convulsions generally occur. While the tests are now carried out on larger animals, requiring much larger dosage per kilogram, the original unit has been adhered to on account of its convenience for clinical purposes. This unit when injected into a human diabetic will enable the patient to utilize or store from 1 to 4 grams additional carbohydrate, depending on the severity of the case.

Since there is variability in the strength of insulin, as now marketed, and because diabetics react to insulin differently, it is well to start with small doses (1 unit) given subcutaneously, two or three times a day twenty to thirty minutes before a meal. The effect of insulin is evident within thirty minutes, reaches its maximum in two to four hours and at the end of six hours usually has disappeared.

The number of these units contained in each cubic centimeter is clearly stated on the label of each package. It is not advisable, however, to put too great reliance on the number of units indicated on the package, as the methods of standardization, at present available, permit of a variation of 10 or 20 per cent., even when the utmost precautions are observed. For this reason patients should be kept under competent observation, especially when changing from one lot number of insulin to another.

Insulin, when given too long before a meal, or when given in too large a dose, will cause a lowering of blood sugar below the

normal level—a hypoglycemia. This is to be avoided, as too great a lowering will cause acute symptoms such as weakness, nervousness and sweating, followed by unconsciousness, which may end fatally. Delirium or convulsions may occur. The premonitory symptoms are quickly overcome by feeding the patient some form of available carbohydrate, preferably orange juice, glucose or cane sugar. Even when comatose, if glucose or sugar can be administered by mouth or by stomach tube, recovery is remarkably rapid. If it is impossible to give carbohydrate in this manner, or the patient is in a critical condition, from 5 to 20 grams of glucose may be injected intravenously, using a five to fifty per cent. sterile solution. This restores the blood sugar and the patient recovers and returns to normal, usually within ten to twenty minutes. (Subcutaneous injection of 5 to 10 minims of a 1 : 1000 solution of adrenalin hydrochloride may obviate the necessity of intravenous glucose injections. If adrenalin is given, and it partially restores the patient, carbohydrate should then be given by mouth.)

This remarkable lowering of the blood sugar by insulin makes necessary extreme caution in its administration. The blood sugar removed from the blood stream and utilized through the influence of the insulin is thus in part replaced by the carbohydrate absorbed following the meal, or to state it in another way, the high blood sugar which usually follows the ingestion of food is prevented and in the diabetic the usual excretion of sugar in the urine does not occur because the carbohydrate is being rapidly stored or utilized by the body.

In those cases receiving insulin without adequate laboratory control of blood sugar, it may be safer to have a blood sugar somewhat above normal with a transient glycosuria, than to have the urine continuously sugar-free with a blood sugar at or below normal. However, in these cases, if the patient be properly informed of the early symptoms of low blood sugar (weakness, nervousness and sweating), and instructed always to have in his possession some form of sugar for immediate consumption, the danger from insulin would be minimized. Oranges, corn or glucose syrup, sugar or candy afford readily available forms of sugar capable of acting rapidly as an antidote for an overdose of insulin.

The insulin treatment is in no sense a cure for diabetes when there is permanent damage and displacement of the islet cells by

scar tissue. Insulin will rest and allow islet cells to recover that
have not been injured beyond the stage at which return to normal
is possible, and consequently the overstrained pancreas regain all
or part of its own power.

In the presence of infection, especially as seen in surgical
cases, much larger doses must be given to obtain results. After
a surgical operation (such as an amputation of a gangrenous leg),
usually smaller doses of insulin are required than before, to main-
tain favorable conditions.

In coma, or cases of severe acidosis, larger doses of insulin
should be given in addition to other measures described on page
758. In these cases carbohydrates should also be given with the
insulin because of the danger of producing hypoglycemia. One
hundred or more units of insulin have been given in these cases
within twenty-four hours. The progress of the case should be
carefully watched by frequent urinary examinations and blood
sugar determinations. Although insulin has been given intra-
venousy and by mouth, the best results thus far have been ob-
tained by subcutaneous injection.

*Insulin should not be given to a non-diabetic, or to a diabetic
on starvation.*

The Treatment of Acidosis and Diabetic Coma.

Acidosis followed by coma was formerly the cause of death
in diabetes more frequently than all other causes collectively.
Diabetic acidosis and coma are much easier prevented than
they are treated and with very much better results. The
proper treatment for acidosis consists in the application of
the proper treatment for diabetes, which has for its object to in-
crease the carbohydrate tolerance of a diabetic, resulting in a nor-
mal blood sugar and the absence of glycosuria Fat taken in ex-
cess of what is required or given when carbohydrates are materially
reduced, or an obese individual deprived of carbohydrate, may
precipitate an attack of acidosis and, if the patient be diabetic, de-
velop into coma.

In bringing about changes in the diet, by removing the fat first,
the modern diabetic treatment prevents acidosis in the same manner
that acidosis is prevented in building up the diet after the urine is
rendered sugar-free, by adding the fat last.

Fat should always be added to the diet after the carbohydrate and protein tolerance have been determined.

If severe acid poisoning results, as the result of failure to carry out the proper diet, the following plan of treatment may be most helpful. It must be strictly remembered that a mild diabetic, by disobeying the rules regarding diet, may be equally liable to develop acidosis as one who has severe diabetes. A mild diabetic need not become a severe diabetic to become susceptible to acid poisoning. Their chances for contracting acidosis are equal.

It is usually well to put the patient to bed with prompt and efficient nursing if acidosis of a severe character develops. The temperature of a diabetic, especially if marked acidosis and evidences of beginning coma develop, is subnormal. The patient should be kept warm and every effort made to conserve body heat. After the source of the acid bodies has been removed or materially reduced, the next step is to remove the acids from the body, which normally is accomplished by the kidneys and the lungs. Therefore by increasing the amount of fluid which will pass through the kidneys, increased amounts of acids can be removed from the body. At least 1000 cubic centimeters of water should be given to an individual by various routes every six hours. It is very necessary to give frequently, by mouth, small quantities of water at ordinary room temperature, so as not to upset the stomach. This also can be given by enteroclysis. Intravenously, salt solution is given in quantities of 250 cubic centimeters to 500 cubic centimeters, which acts as a stimulant to the heart as well as a rapid method of causing elimination by the kidneys. Hypodermoclysis into the loose tissues of the body, giving 250 cubic centimeters to 300 cubic centimeters under strictly aseptic conditions, is a very valuable method of introducing fluid into the body.

The body also requires salt and this is given in broths if the patient is able to swallow, or in salt solution when given by bowel, intravenously or by hypodermoclysis. In this manner the body is supplied with both salt and water. Edema in diabetic acidosis and coma is not common, but when present would contraindicate the use of salt.

The lungs, in addition to the kidneys, are the organs of excretion for acids of the volatile type. Means of easy respiration for the patient should be afforded by comfortable bed, pillows, bed clothing, loosely fitting night clothes, and abundance of fresh air.

The bowels should be repeatedly evacuated by enemata. Diarrhea may occur as the result of too free use of cathartics, which further reduces the vitality of the patient. If the patient has been using cathartics with good effect they should be continued. Diarrhea may also occur as an effort on the part of the patient to aid elimination. The free action of the bowels may relieve the kidneys by eliminating some of the substances usually excreted by this route.

If vomiting and nausea are present, washing out the stomach is usually most effective in relieving the condition, although this procedure may have to be repeated.

The use of alkali continues to be regarded by Joslin[35] as dangerous and he claims that he has had better results without its use than with it. He also states that it is quite conceivable that alkalies may be useful.[35] Under this same discussion he enumerates a number of reasons why he does not believe in the use of alkalies in the treatment of acidosis, which briefly are as follows: Alkalies upset the digestion. Few stomachs can stand one hundred grams or more of bicarbonate of soda in twenty-four hours, which is the amount necessary to render the urine alkaline. Alkalies liberate acids so rapidly in the body that the kidneys are overwhelmed by their presence interfering with elimination. This damage to the kidneys may cause anuria. Alkalies given in large doses intravenously, have given rise to convulsions and death. Alkalies may interfere with the proper oxidation of the ketone bodies and with the mechanism for producing ammonia, which is the body's alkali, developed to meet the emergency. Alkali restored in the blood, and alkaline urine has not changed the progressive downward course of diabetic coma.

In cases where it has been decided to use alkali, sodium bicarbonate is given in doses up to one hundred grams daily, if the stomach will tolerate this amount.

It may also be given intravenously by making a two to four per cent. solution, sterilizing by boiling, and then bubbling CO_2 gas through it until the alkaline reaction disappears.

Insulin Treatment. It would appear from our present state of knowledge that to treat acidosis or coma of diabetic origin, as heretofore described, is no longer warranted in view of the consistently poor results obtained.

The use of insulin, described in detail on page 755, has revolutionized the treatment of coma and severe acidosis in diabetes. In fact, in diabetic coma insulin may be said to be a specific. Great benefits are to be expected in the treatment of coma with insulin, as compared with the unsatisfactory methods consisting of diet and alkali, heretofore in use. In coma or cases of severe acidosis insulin should be given in much larger doses, 70 to 100 or more units in twenty-four hours, depending on the severity of the condition, and upon the patient's reaction to the insulin as determined by the blood sugar percentage, the urinary sugar and the volume per cent. of CO_2 in the blood. Although insulin has been given experimentally by mouth, by rectum and intravenously, the best results have attended the subcutaneous injection. It is well to administer with the insulin, glucose or sugar by mouth, by stomach tube, by rectum; or 5 to 20 grams of glucose can be given intravenously, on account of the great danger of producing hypoglycemia with its alarming symptoms. If symptoms of approaching dangerous hypoglycemia are not recognized and treated, as described on page 755, the outcome may be fatal. Symptoms of hypoglycemia have become manifest when the blood sugar was reduced to 0.07 per cent. although they may not be present until the blood sugar percentage is reduced to 0.05 per cent. Subcutaneous injections of 5 to 10 minims of 1:1000 solution of adrenalin chloride may obviate the necessity of giving intravenous glucose injections to relieve symptoms of hypoglycemia. If adrenalin thus given partially restores the patient, it will be only for a short time, and carbohydrate should be given by mouth, for a more lasting effect.

Every diabetic patient, who because of previously existing conditions, such as infected limbs, carbuncles, cellulitis, surgical operations for acute conditions, may develop coma, and should have insulin available for treatment. Diabetic patients who suffer from septicemia, cardiorenal disease, and develop diabetic coma may die in spite of insulin being used, not due to failure of the insulin to act, but to the accompanying disease, *i.e.,* cardiorenal septicemia, etc.

FOOD FOR DIABETICS.

The subject of diets receives a great deal of thought and consideration from both the physician and diabetic, the for-

mer because, by means of a proper diet the condition of the patient can be greatly improved, and the latter because he is interested in it from the standpoint of satisfying his appetite, which during the time the disease was untreated claimed so much of his attention. The successfully treated diabetic is interested in diet because he desires to remain symptom free.

Many foods have been and continue to be recommended as having some specific qualities favorable to the course of diabetics. The physician and the patient should always be sure that they are fully informed as to the composition of any food recommended for diabetics.

Bread. This article of diet is extensively used by diabetics, and is the one article, as a general rule, they crave more than any other. Many of the substitutes for bread, exposed for sale in various stores and drug shops, are as harmful, if not more so, than bread itself. Gluten bread seems traditionally to have been recommended as being a suitable substitute. Its use, as a general rule, is contraindicated, unless one definitely knows its carbohydrate content. Various forms of bread, such as whole wheat, rye, and black bread, especially among foreigners, are thought to be suitable substitutes, but they contain nearly as much carbohydrate as does the ordinary wheat bread, whose carbohydrate content varies from fifty to sixty per cent. in different samples.

Bran is a very suitable substitute which can be used in making muffins. These bran muffins are used instead of bread. By "bran" is meant the coarse bran that is sold in feed stores, used as food for cattle, and prepared for human consumption by washing with water to rid it of its starch. The best method of accomplishing this is to put the bran in a cheesecloth bag and attach it to a spigot and allow the water to wash through the bag and its contents slowly for an hour, thereby practically washing out all the starch. The bran is then allowed to dry, after which it is ready for use.

Bran gives bulk, prevents constipation, and is low in its caloric food content. Beware of employing for diabetics the bran that is sold in shops. It is usually prepared for the treatment of constipation alone and in order to make it more palatable additional carbohydrate is added. This same bran is made into biscuits offered for sale especially for constipa-

tion. · Diabetic bran to the novice is frequently difficult 'to make into biscuit form. The addition of spices, a few nuts, or by using bacon fat in the preparation of the bran biscuits may overcome the objection made, to their lack of taste. Diabetics crave for "something to spread their butter on," and bran biscuits offer the best we have at present.

Various flours of high protein content, with carbohydrate which is unassimilable, are on the market and offer suitable means of preparing food ordinarily made of wheat flour. Milk is another article of diet that diabetics may desire to use as such, or modified. The cream is probably the best part of the milk to use, because of the low protein and carbohydrate and the high fat content. Cream may be diluted with carbonated water to increase the quantity without increasing the calories. The use of various brands of canned milk, condensed milk, malted milk, or milk powders should, as a general rule, be avoided. Frequently sugar in some form is added to these preparations. Milk from which the sugar has been removed has been offered for sale in Boston by D. Whiting & Sons. Full directions for its preparation and use accompany the article.

The mild diabetics need very little special food preparation, since they are usually able to select their food from almost any general menu. Desserts for a diabetic may be prepared from gelatin, flavored with lemon, vanilla, orange, raspberry, or coffee extracts. Sliced orange, grapefruit and strawberries in season, are welcomed as desserts. Sea moss and agar agar have also been used in preparing desserts.

Lister's Flour, Hepco flour, Cellu flour and Diaprotein are among the flours which can be used as substitutes for flour of high carbohydrate content. Their protein content must, however, be reckoned with.

Saccharin can be used to sweeten some foods but it is best to avoid, if possible, the taste for sugar. Saccharin can be dissolved one grain to an ounce of water and enough of the resulting solution used to flavor. If more is added than is required to sweeten, a bitter taste results. Saccharin should never be cooked. If it is to be added to food to be cooked, it is best added late in the process of cooking, otherwise a

bitter taste will result. Saccharin in amounts of one and one-half grains per day seems to do no harm.

Allen[36] has used plain talcum powder as a substitute for powdering pans to prevent food from sticking and for other similar purposes. It in itself has no food value and serves a useful purpose. He also calls attention to the use of *India gum,* which can be purchased from Jaburg Brothers, New York City, as a substance which can be used for giving body and glutinous consistency to foods. It is crude gum arabic and has very little food value. Allen has also successfully used liquid petrolatum as a substitute for oils in salad dressing, as a greasy medium for frying foods, greasing pans and as a substitute for lard. Petrolatum has no food value, being a mineral oil, as only oils or fats of the animal or vegetable kingdoms have food values.

By means of resourcefulness on the part of the dietitian or cook, a liberal supply of formulas can be readily accumulated, beginning with the recipes accompanying various flours and those already in use by diabetics.

List of Food Values Useful in the Treatment of Diabetes Mellitus.*

30 grams (1 oz.) contain approximately	Carbohyd.	Protein	Fat	Calories
Fat	0	5.0	0	20
Meat (uncooked lean)	0	6	3	50
Meat (cooked lean)	0	8	5	77
Chicken (cooked lean)	0	8	3	59
Bacon	0	5	15	155
Cheese	0	8	11	131
Egg	0	6	6	78
Broth	0	0.7	0	3
Butter	0	0	25	225
Cream—40 per cent.	1	1	12	120
Cream—20 per cent.	1	1	6	60
5 per cent. vegetables	1	0.5	0	6
10 per cent. vegetables	2	0.5	0	10
Milk	1.5	1	1	20
Oysters (six)	4	6	1	50
Potato	6	1	0	28
Bread	18	3	0	84
Oatmeal (dry)	20	5	2	118
Shredded wheat	23	3	0	104

*See also Chemical Composition of American Food Materials, page 776.

Water, clear broths, coffee, tea, cocoa shells, and cracked cocoa can be taken without allowance for food content.

Foods arranged approximately according to content of carbohydrates.		
5%	10%	15%

* Reckon average carbohydrate in 5% vegetable as 3%; of 10% vegetable as 6%.

	1% – 3%	3% – 5% *	10% *	15%
VEGETABLES, fresh or canned.	Lettuce	Tomatoes	String beans	Green peas
	Cucumbers	Brussels	Pumpkin	Artichokes
	Spinach	sprouts	Turnip	Parsnips
	Asparagus	Water cress	Kohl-Rabi	Canned lima
	Rhubarb	Sea kale	Squash	beans
	Endive	Okra	Beets	
	Marrow	Cauliflower	Carrots	
	Sorrel	Egg plant	Onions	
	Sauerkraut	Cabbage	Green peas	
	Beet greens	Radishes	canned	
	Dandelion	Leeks		
	greens	String beans	Watermelon	Raspberries
	Swiss chard	canned	Strawberries	Currants
	Celery	Broccoli	Lemons	Apricots
	Mushrooms	Artichokes	Cranberries	Pears
		canned	Peaches	Apples
FRUITS			Pineapple	Huckleberries
	Ripe olives (20 per cent. fat)		Blackberries	Blueberries
	Grapefruit		Gooseberries	Cherries
			Oranges	

1 gram protein ....4 calories.	1 kilogram = 2.2 pounds.
1 " carbohydrate ...4 "	30 grams g or cubic centi-
1 " fat ....9 "	meters c.c. = 1 ounce.
6.25 " protein contain . 1 g. nitrogen.	A patient "at rest" requires
	25 calories per kilogram.

30 grams (1 oz.) contain approximately	Carbohyd. G	Protein G	Fat G	Calories
Oatmeal, dry wgt.	20.0	5.0	2	118
Shredded wheat	23	3	0	104
Cream, 40 per cent.	1	1	12	116
Cream, 20 per cent.	1	1	6	62
Milk	1.5	1	1	19
Brazil nuts	2	5	20	208
Oysters, six	4	6	1	49
Meat (uncooked, lean)	0	6	3	51
Meat (cooked, lean)	0	8	5	77
Chicken (cooked, lean)	0	8	3	59
Bacon	0	5	15	155
Cheese	0	8	11	131
Egg (one)	0	6	6	78
Vegetables 5 per cent. group ...	1	0.5	0	6
Vegetables 10 per cent. group .	2	0.5	0	10
Potato	6	1	0	28
Bread	18	3	0	84
Butter	0	0	25	225
Oil	0	0	30	270
Fish, Cod, Haddock, cooked ..	0	6	0	24
Broth	0	0.7	0	3
Fruit, 10 per cent.	3	0	0	12

[1]According to Joslin. These forms may be purchased from Thomas Groom & Co., 105 State Street, Boston, Form J 6.

DIABETIC DIETS

Test diets — Protein and fat (PF) columns: Skimmed milk, Fish, Meat, Butter, Bacon, Cream 20% fat, Egg. Carbohydrate (C) columns: Bread, Potato, Uneeda, Shredded wheat, Oatmeal, Orange, 5% Vegetable.

Name of diet	Skimmed milk	Fish	Meat	Butter	Bacon	Cream 20% fat	Egg	Bread	Potato	Uneeda	Shredded wheat	Oatmeal	Orange	5% Vegetable	Calories	Fat	Protein	Carbohydrate	Diets with which to become sugar free
1	480	120	90					90	240		1		300	300	1247	15	89	189	T. D. 1
2	300	180							120		1		300	300	640	0	58	102	T. D. 2
3	240	90							60				300	300	388	0	33	64	T. D. 3
4	120	90											200	300	252	0	27	36	T. D. 4
5													50	300	80	0	5	15	T. D. 5

Maintenance diets

Name of diet	Meat	Butter	Bacon	Cream 20% fat	Egg	Potato	Uneeda	Shredded wheat	Oatmeal	Orange	5% Vegetable	Calories	Fat	Protein	Carbohydrate	Diets
1					1					100	300	138	6	11	10	C1+PF1
2					1					100	300	302	18	13	22	C2+PF2
3			30	60	2					200	600	440	24	24	32	C3+PF3
4			30	60	2					200	600	635	39	29	42	C4+PF4
5		15	30	60	2				15	200	600	813	53	32	52	C5+PF5
6	30	15	30	90	2				30	300	600	1009	65	43	63	C6+PF6
7	60	15	30	90	2				30	300	600	1126	70	51	73	C7+PF7
8	90	30	30	90	2		2		30	300	600	1351	87	59	83	C8+PF8
9	90	30	30	120	2		2	½	30	300	600	1469	93	62	96	C9+PF9
10	90	30	30	120	2		2	1	30	300	600	1517	93	63	107	C10+PF10
11	120	30	30	120	2	120	2	1	30	300	600	1706	98	75	131	C11+PF11
12	120	30	30	120	2	240	2	1	30	300	600	1818	98	79	155	C12+PF12

Food	Weight in grams	Approximate equivalent
Orange	300	One and one-half (large size)
5% vegetables	300	Three moderate portions
Skimmed milk	480	One pint (16 ounces)
Fish	120	Two small portions
Potato	240	Two medium sized potatoes
Meat	90	One moderate portion

Food	Weight in grams	Approximate equivalent
Bread	90	Three small slices
Oatmeal (dry wgt)	30	One large saucerful
Cream	60	Four tablespoonfuls
Bacon	30	Four crisp strips
Butter	30	Three medium portions

According to Joslin—Form 4.   Thomas Groom & Co. Boston, Mass.

RECIPES FOR THE PREPARATION OF
FOODS FOR DIABETICS.*

DIABETIC MUFFINS.

1 Box Lister's Diabetic Flour.
1 Egg.
3 Tablespoonfuls of sweet heavy cream (40 per cent. cream).
2 Tablespoonfuls of bacon fat.

Same quantity of butter, melted lard or Crisco may be used in place of the bacon fat. This will make eight muffins, each muffin having an equivalent to one egg (or protein, 6 grams; fat, 6 grams; calories, 78).

Method: Beat white of egg very stiff; beat yolk separately from white; to the beaten yolk add the cream and beat; then add bacon fat (butter, melted lard or melted Crisco); beat again and then add the beaten white of egg; lastly the flour, beating the mixture all the while the flour is slowly added. Put in buttered, hot muffin tins and bake from ten to twenty minutes. If coal range is used, bake for fifteen minutes and have the oven hot. Use old fashioned cast-iron muffin iron.

DIABETIC BREAD OR BISCUITS.

1 Box Lister's Diabetic Flour.
3 Eggs.

Method: Separate whites and yolks of eggs. Add to whites salt to taste. Beat whites until very stiff. Beat yolks until thick and lemon colored. Combine and beat with egg beater. Fold in gradually 1 box Lister's Diabetic Flour. Bake in tin 5 inches long, 3 inches wide and 3 inches high (straight sides). Have oven hot. If baked in gas-stove oven, bake for fifteen minutes full heat, then reduce heat one-half for ten minutes longer. If baked in coal or wood oven bake from fifteen to thirty minutes. Do not remove from tin until cooled. Each loaf contains protein, 58 grams; fat, 18.6 grams; calories, 397. If desired this may be made into biscuits. The bread or biscuits may be flavored with nutmeg or cloves.

LISTER'S FLOUR AND BRAN MUFFINS.
(Useful in Diabetic Constipation)

1 Level tablespoonful lard, bacon fat, butter or Crisco.
1 Egg.
1 Cup washed bran.
1 Package Lister's Flour.
⅓ Cup water or less.

Tie dry bran in cheesecloth and soak one hour. Wash by squeezing water through and through. Change water several times; wring dry. Separate egg and beat thoroughly. Add to the egg yolk the melted lard and beaten egg white. Add Lister's Flour, washed bran and water. Make nine muffins.

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* Liberal use has been made of the following books in seeking suggestions for suitable preparations of food for diabetics:

Starvation (Allen) Treatment of Diabetes, Hill and Eckman. W. M. Leonard, 1915, Boston, Mass., 3d edition.

A Primer for Diabetic Patients, Wilder, Foley, Ellithorpe. W. B. Saunders Co., 1921, Philadelphia.

Diabetic Manual, Joslin. Lea and Febiger, Philadelphia, 2d edition, 1919.
Recipes in use in the Diet Kitchen of Jefferson Hospital, Philadelphia, Pa.

DIABETIC COOKIES.

1 Box Lister's Diabetic Flour.
1 Egg.
3 Tablespoonfuls cream.
3 Tablespoonfuls of butter or bacon fat.

Method: Beat egg until light. Add cream and beat again. Add butter and beat again. Then add Lister's Flour slowly. A little caraway seed, ginger or vanilla may be added to suit the taste. Roll very thin and only a small amount at a time. Bake in hot oven about ten minutes. Makes thirty cookies of about 23 calories each.

SOYA MEAL AND BRAN MUFFINS.*

1 Ounce (30 grams) soya meal.
1 Level tablespoonful (15 grams) butter.
1 Ounce (30 c.c.) 40 per cent. cream.
1 Cup washed bran (see method given elsewhere).
1 Egg-white.
1 Whole egg may be substituted for 1 egg-white.
¼ Teaspoon salt.
1½ Teaspoons baking powder.

Mix soya meal, salt and baking powder. Add to the washed bran. Add melted butter and cream. Beat egg-white and fold into mixture. Add enough water to make a very thick drop batter. Bake in six well-greased muffin tins until golden brown, from fifteen to twenty-five minutes.

Total food value:

Protein .... 11 grams
Carbohydrate .... 1 gram
Fat .... 27 grams
Calories 300

One muffin = Protein, 2 grams; fat, 4.5 grams; Carbohydrate, trace; Calories, 50.

CASOID FLOUR AND BRAN MUFFINS.**

1 Ounce (30 grams) Casoid flour.
1 Level tablespoon (15 grams) butter.
1 Ounce (30 c.c.) 40 per cent. cream.
1 Egg-white.
1 Whole egg may be substituted for 1 egg-white.
¼ Teaspoon salt.
1½ Teaspoonful baking powder.
1 Cup washed bran.

Method as in previous rule. Bake in six muffin tins.

Total food value:

Protein .... 18 grams
Carbohydrate .... 1 gram
Fat .... 24 grams
Calories 300

One muffin = Protein, 3 grams; Fat, 4 grams; Carbohydrate + Calories, 50.

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* Soya Bean Meal, Theodore Metcalf Co., Boston, Mass.
** Casoid Diabetic Flour, Thos. Leeming and Co., Importers, New York City.

DIAPROTEIN BREAD (Sponge Bread).

1 Measure of Diaprotein.
2 Eggs.
2 Tablespoons of warm water.

Directions: Separate white and yolks of eggs. Add to white a pinch of salt (and if desired ½ grain tablet of saccharin, crushed and powdered). To the yolk add the water. Beat both separately, the white until stiff, and the yolk until thick; combine both and beat again, then fold (not stir) gradually with a tablespoon, one measure of Diaprotein. Don't stir the mixture. Place in a small baking pan (butter pan well), place pan in baking oven, starting with medium heat and increase heat at end. Have the bread cool down in baking pan before taking out. When taken out, wrap in towel and keep in an ordinary bread pan. If mixture runs over in oven, the heat to start is too great. Vanilla, lemon or any kind of spice like ground cinnamon, ground alspice, cloves, anise, caraway, etc., according to the liking of the individual, will give a variety of flavors. If more sweetness in the bread is required add one or two saccharin (½ grain) tablets, powdered.

Food Value: The above recipe bakes a loaf of sponge bread having a caloric equivalent of 330 calories.

DIAPROTEIN BRAN BREAD.

1 Measure of Diaprotein.
2 Or 3 whites, 2 yolks.
1 Cup washed bran.
3 Tablespoonfuls of warm water.
1 Tablespoonful melted butter.
½ Teaspoonful baking powder.

Directions: Separate white and yolk. Add to white a pinch of salt. To the yolk add the water, beat both separately with egg beater, first the white until stiff, then the yolk until thick; combine both and beat thoroughly again. Then fold in (not stir) gradually with a tablespoon the Diaprotein and the washed bran. Don't stir the mixture. Place in a small well buttered baking pan; place pan in oven, starting with moderate heat, gradually increasing until baked.

Have the bread cool down in pan before taking it out. After the bread is taken out, wrap in a towel and keep in the bread pan. If mixture runs over, the heat to start, is too great.

Ordinary dry bran has to be placed in a small piece of cheesecloth and hung under running water for an hour. Squeeze the water out a few times, wring dry, and then place bran in oven to insure its drying thoroughly, and grind it fine.

Heat equivalent of the above recipe, 580 calories.

DIAPROTEIN BOSTON BRAN BREAD.

The same recipe as Diaprotein Bran Bread but the washed and dried bran must be finely ground. It is advisable that a large quantity of bran should be prepared at one time, to avoid the troublesome repetition of preparing.

This Boston Bran Bread has the nearest taste of bread, is nourishing and especially healthful and strongly recommended.

DIAPROTEIN MUFFINS.

1 Measure of Diaprotein.
1 Egg.
2 Tablespoonfuls of bacon fat, level full.
3 Tablespoonfuls of water (preferably warm water) .
(Instead of bacon fat the same quantity of melted butter,
melted lard or crisco can be used.)

Directions: Separate white and yolk. Add to white a pinch of salt
(and if desired ½ grain tablet saccharin crushed and powdered), add to
the yolk bacon fat and water; beat the white with an egg beater until
stiff and the yolk until thick; combine both and beat the Diaprotein in
gradually. This will make six to eight muffins.

DIAPROTEIN BRAN MUFFINS.

1 Measure of Diaprotein.
2 Tablespoonfuls of lard (or crisco, melted bacon fat or
butter), level full.
2 Eggs.
1 Cup washed bran.
½ Cup of water (preferably warm).
½ Teaspoonful baking powder.

Separate white and yolk. Add to white a pinch of salt, add to the yolk
bacon fat and water. Beat the white with egg beater until stiff and the
yolk until thick, and then combine the two. Sift Diaprotein into bran and
then fold gently into eggs. This will make six to eight muffins.

Before using, the dry bran must be placed in a small piece of cheese-
cloth and hung under running water tap for an hour. Squeeze the water
out a few times, wring it dry, and then place bran in oven to insure drying
thoroughly.

HEPCO CAKES.

So arranged that one cake is equivalent to an egg.
Hepco flour ....140 grams
Eggs .... 2 grams
Cream, 40 per cent. .... 60 c.c.
Butter .... 10 grams

Make 12 cakes. Each cake contains 6 grams protein, 6 grams fat and ap-
proximately 75 calories.

CELLU-BRAN BREAD.*

Cellu-flour ....80 grams.
Dry, washed bran ....50 grams.
Baking powder ....10 grams.
India gum ....4 tablespoonfuls
Mineral oil ....10 grams.
Hot water
Salt.

Mix dry ingredients thoroughly. Add the oil and just enough hot
water to enable the mixture to be moulded into a loaf about 2 inches in
thickness. Bake in a greased pan in a very slow oven. Time required
for baking, one to one and one-half hours. Wet, washed bran may be used
if the quantity of water is diminished accordingly. No food value.

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* Cellu-flour, prepared by Dietetic Cellulose Company, 2557 W. Chicago
Ave., Chicago, Ill.

CELLU-BRAN MUFFINS.

Cellu-flour .... 80 grams
Dry, washed bran .... 50 grams
Baking powder .... 10 grams.
India gum ....4 tablespoonfuls
Mineral oil ....10 grams.
Saccharin .... ½ grain
Hot water
Salt

Mix ingredients thoroughly. Add oil and saccharin dissolved in a small amount of water. Add hot water sufficient to make a mixture which can be easily moulded. Place in muffin tins, greased with mineral oil. Bake in a very slow oven, increasing heat to brown. No food value.

CELLU-BRAN COOKIES.

Cellu-flour .... 25 grams
Dry, washed bran .... 60 grams
Cinnamon .... 1 teaspoonful
India gum .... 10 grams.
Mineral oil .... 6 tablespoonfuls
Hot water ....100 grams
Saccharin .... 1 grain
Vanilla
Salt

Mix dry ingredients thoroughly. Add oil, vanilla and hot water, in which the saccharin has been dissolved. Shape into very thin cookies and bake in a hot oven until crisp and brown. No food value.

BRAN CAKES FOR CONSTIPATION.

Bran ....420 grams
India gum .... 30 grams
Water ....2½ tablespoonfuls
Salt .... 1 teaspoonful

Put the bran in a double cheesecloth bag. Wash under the cold water tap until the water runs clear, about one hour. Mix India gum and water to a thick paste. Mix with washed bran, kneading the bran and gum together. Caraway seeds may be added. Spread in a thin layer on a baking sheet or on the bottom of baking pans and press smooth and flat and firm. Cut into cakes of desired size and bake in a moderate oven until biscuits are dry and crisp. No food value.

FRENCH TOAST.

1 Egg.
2 or 3 Tablespoonfuls cream.
Lister's muffins, biscuits or bread.

Beat the egg and cream together. Slice Lister's muffins, biscuits or bread. Soak the slices in the egg and cream, and fry in a little hot butter until brown.

Follow all directions exactly as given. The batter may appear to be too thick or heavy, but no more moisture should be added than is called for in these directions.

BRAN CAKES FOR DIABETICS.

Bran .... 2 cupfuls
Melted butter .... 31 grams
Eggs (whole) 2
Egg-white (1) .... 25 grams
Salt .... 1 teaspoonful
Water

Tie bran in cheesecloth and wash thoroughly by fastening on the water tap until water comes away clear. The bran should be frequently kneaded so that all parts come in contact with the water. Wring dry. Mix bran, well-beaten whole eggs, butter and salt. Beat the egg-white very stiff and fold in at the last. Shape with knife and tablespoon into three dozen small cakes. If desired one-half gram of cinnamon or other flavoring may be added. Each cake contains: Protein, 0.5 gram; fat, 1 gram; calories, 11.

CELLU-FLOUR GRIDDLE CAKES.

Egg 1
Salt
Hot water .... 2 tablespoonfuls
Cellu-flour

Beat egg until light and creamy. Add salt, water and sufficient cellu-flour to make a thick batter. Fry on hot griddle greased with mineral oil. This recipe contains 6 grams protein and 6 grams fat.

TOMATO SOUP.

Clear broth .... 1 cupful
Tomatoes, cooked .... 80 grams
Onions, uncooked .... 10 grams

To one cup of clear broth add 80 grams of tomatoes and 10 grams of onions cut fine. Cook for fifteen minutes. Season with salt and pepper and serve. Food value: 3 grams carbohydrate; 1 gram protein.

VEGETABLE SOUP.

Clear broth .... 2 cupfuls
5 per cent. vegetables, uncooked .... 50 grams
10 per cent. vegetables, uncooked .... 25 grams

To 2 cupfuls of clear broth add 30 grams of tomato, 10 grams of celery, 10 grams of cabbage, 15 grams of onions, and 10 grams of carrots. Cook until vegetables are tender. Season with salt and pepper. Food value: 3 grams carbohydrate; 1 gram protein.

ASPARAGUS SOUP.

12 Stalks asparagus, or
⅓ Cup canned asparagus tips.
⅔ Cup chicken stock.
¼ Slice onion.
   Yolk of one egg.
 1 Tablespoonful heavy cream.
⅛ Teaspoonful salt.
   Few grains of pepper.

Cover asparagus with cold water, bring to boiling point, drain, and add stock and onion; let simmer eight minutes, rub through a sieve, reheat, add cream, egg and seasonings. Strain and serve.

CHICKEN SOUP WITH BEEF EXTRACT.

½ Cup chicken stock.
½ Teaspoon Sauterne.
⅛ Teaspoon beef extract.
1½ Tablespoonful cream.
Salt and pepper.

Heat stock to boiling point and add remaining ingredients.

TOMATO BISQUE.

⅔ Cup canned tomatoes.
¼ Sliced onion.
   Bit of bay leaf.
2 Cloves.
¼ Cup boiling water.
⅛ Teaspoonful soda.
½ Teaspoon butter.
¼ Teaspoon salt.
   Few grains pepper.
2 Tablespoons heavy cream.

Cook first five ingredients for eight minutes. Rub through sieve, add soda, butter in small pieces, seasoning and cream. Serve at once.

SCALLOPED FISH.

Flake any cooked fish, moisten with broth, tomato or cream, season, place in baking dish and cover with bran muffin dried and crumbled fine. Meat, hard-boiled eggs or vegetables may be prepared in the same way.

FRIED FISH.

Dry whole small fish, or pieces suitable for serving, rub with mineral oil and coat with crumbs prepared as for scalloped fish. Fry in mineral oil or bake in a hot oven. Tomato cut in thick slices may be prepared the same way.

SALT CODFISH WITH CREAM.

Pick salt codfish into flakes; there should be two tablespoons. Cover with lukewarm water and let stand on back of stove until soft. Drain and add three tablespoons cream; as soon as cream is heated add yolk of one small egg slightly beaten.

NEW ENGLAND BOILED DINNER.

Meat, uncooked .... 60 grams
5 per cent. vegetables, uncooked .... 100 grams
10 per cent. vegetables, uncooked .... 100 grams
15 per cent. vegetables, uncooked .... 25 grams
Potato, uncooked .... 100 grams

To 60 grams of corned beef add three cupfuls of boiling water; simmer until meat is tender. Remove meat; add 100 grams of cabbage, 50 grams of turnips, 50 grams of carrots, 25 grams of parsnips, and 100 grams of potato. Boil until tender. Add meat and serve. Season with salt and pepper. Food value: 33 grams carbohydrate; 19 grams protein. 8 grams fat.

BEEF STEW.

Meat, uncooked .... 125 grams
   5 per cent. vegetables, uncooked .... 50 grams
  10 per cent. vegetables, uncooked .... 50 grams

To 125 grams of meat add 3 cupfuls of boiling water and ¼ teaspoon salt, and let simmer until tender. Remove meat from water and add 50 grams of cabbage, 25 grams of carrots, and 25 grams of onions. Boil until vegetables are tender. Add meat and serve. Food value: **5** grams carbohydrate; **26** grams protein; **15** grams fat.

BEEF STEW.

Meat, uncooked .... 60 grams
   5 per cent. vegetables, uncooked .... 200 grams
  10 per cent. vegetables, uncooked .... 100 grams

To 60 grams meat add 3 cupfuls boiling water and ½ teaspoon salt, let simmer until meat is tender. Remove meat from water and add 100 grams of tomato, 100 grams of cabbage, 50 grams of carrots, 50 grams of onions. Boil until vegetables are tender. Add meat and serve. Food value: **12** grams carbohydrate; **16** grams protein; **8** grams fat.

ROAST PORK AND FRIED APPLES.

Roast pork, cooked ....~......................... 50 grams
Apple .... 75 grams
Butter .... 10 grams

Put 50 grams of roast pork (cooked) into a small dish. Cover with 75 grams of apples sliced and 10 grams of butter. Add a small amount of water; cover and bake in a moderate oven about twenty minutes. Food value: **12** grams carbohydrate; **14** grams protein; **16** grams fat.

CREAMED CHICKEN WITH ASPARAGUS.

Chicken, cooked .... 75 grams
Asparagus, cooked .... 100 grams
Milk .... 80 grams
Cream .... 20 grams
Butter .... 5 grams

Cut 75 grams of cooked chicken into small pieces. Add 100 grams of asparagus. Heat 80 grams of milk, 20 grams of cream, 5 grams of butter. Pour over chicken and asparagus and reheat. Season with salt and pepper. Food value: **8** grams carbohydrate; **22** grams protein; **21** grams fat.

CHICKEN STEW.

Chicken broth .... 1½ cupfuls
Chicken, cooked .... 50 grams
Potato, uncooked .... 100 grams
Cream .... 60 grams
Milk .... 80 grams
Butter .... 10 grams
Peas .... 65 grams

Cook 100 grams of potato in 1½ cupfuls of clear chicken broth; save ½ cupful of the broth and add to it 60 grams of cream, 80 grams of milk, and 10 grams of butter. Heat and add the cooked potato, 50 grams of cooked chicken, and 65 grams of cooked peas. Season with salt and pepper. Food value: **37** grams carbohydrate; **25** grams protein; **29** grams fat.

SQUAB.

A squab when carefully boned yields 50 grams of meat. This is broiled in an oiled paper case to prevent evaporation, and when served with the escaped juices proves a favorite dish for patients. It contains about 12 grams protein and 5 grams fat.

DROPPED EGG.

Butter a muffin ring, and put it in an iron frying pan of hot water to which ½ tablespoon of salt has been added. Break egg into saucer, then slip into ring allowing water to cover egg. Cover and set on back of range. Let stand until egg-white is of jelly-like consistency. Take up ring and egg, using a buttered griddle turner, place on serving dish. Remove ring and garnish egg with parsley.

CREAMED EGGS.

Egg	1 gram
Egg-white	1 gram
Milk	100 grams
Cream	30 grams
Butter	6 grams

Cut one hard-boiled egg and the white of another hard-boiled egg into pieces and add them to 100 grams of milk, 30 grams of cream, and 6 grams of butter which have been mixed together and heated. Season with salt and pepper. Food value: 60 grams carbohydrate; 15 grams protein; 19 grams fat.

EGGS.

Any recipe for cooking eggs may be used if water, cream, tomato or broth is used in place of milk and the butter is omitted or mineral oil is substituted for it.

CREAMED POTATO.

Potato, cooked	100 grams
Cream	30 grams
Milk	30 grams
Butter	5 grams

Mix 30 grams of cream, 30 grams of milk, and 5 grams of butter, and heat. Add 100 grams of cooked potato, diced. Season with salt and pepper and serve. Food value: 24 grams carbohydrate; 4 grams protein; 12 grams fat.

SPINACH.

Chop one cup cooked spinach drained as dry as possible. Season with salt and pepper, press through a purée strainer, reheat in butter, using as much as desired or as much as the spinach will take up. Arrange on a serving dish and garnish with white of hard-boiled egg cut in strips and yolk forced through strainer.

MUSHROOMS IN CREAM.

Clean, peel and break in pieces six medium sized mushroom caps. Saute in one-half tablespoon butter three minutes. Add one and one-half tablespoons cream and cook until mushrooms are tender. Season with salt and pepper and a slight grating of nutmeg.

FRENCH DRESSING.

⅛ Teaspoon salt.
    Pepper.
1 Teaspoonful vinegar.
1 Tablespoonful mineral oil.

Mix in order given, chill and beat or shake in a stoppered bottle until thick. Serve immediately.

BOILED DRESSING.

½ Teaspoonful salt.
    Pepper.
1 Egg or 2 egg yolks.
¾ Cup cream or cream and water.
2 Tablespoonfuls vinegar.

Mix in the order given, adding the vinegar slowly to the other ingredients; cook over hot water until thickened, stirring all the time; chill, strain and serve.

TOMATO JELLY SALAD.

The proportions given are for use with granulated gelatin; if powdered gelatin is used a little more may be required.

2 Teaspoonfuls gelatin.
2 Tablespoonfuls cold water.
¼ Teaspoonful salt.
240 Grams stewed and strained tomato.

Soak the gelatin in cold water ten minutes, dissolve in the hot tomato, season, mould and chill. A bit of bay leaf, two cloves and a slice of leek, or a few chopped chives, may be stewed with the tomato.

CABBAGE AND CELERY SALAD.

Wash and scrape two stalks of celery, add an equal quantity of shredded cabbage, and six walnut meats broken in pieces. Serve with dressing.

EGG SALAD.

Cut one hard-boiled egg in halves crosswise, in such a way that tops of halves may be left in points. Remove yolk, mash, moisten with cream, French or mayonnaise dressing, shape in balls, refill whites, and serve on lettuce leaves. Garnish with thin slices of radish, and a radish or so cut so as to represent a tulip.

ASPARAGUS SALAD.

Drain and rinse four stalks of canned asparagus. Cut a ring one-third inch wide from a red pepper. Put asparagus stalks through ring, arrange on lettuce leaves, and pour over French dressing.

ORANGE ICE.

⅓ Cup orange juice.
1 Teaspoonful lemon juice.
2 Tablespoonfuls cold water.
½ Grain saccharin dissolved in
½ Teaspoonful cold water.

Mix ingredients in order given and freeze.

PRINCESS PUDDING.

 1 Egg yolk.
 ¾ Teaspoonful boiling water.
 2 Teaspoonfuls lemon juice.
 ¼ Grain saccharin dissolved in
 ¼ Teaspoonful cold water.
 1 Egg-white.

Beat egg yolk until thick and lemon-colored, add gelatin, continue the beating. As mixture thickens add gradually the lemon juice and saccharin. Fold in white of egg beaten until stiff and dry. Turn into a mould and chill.

LEMON CREAM SHERBET.

 ¼ Cup cream.
 2 Tablespoonfuls cold water.
 ½ Grain saccharin dissolved in
 ½ Teaspoonful cold water.
 4 Drops lemon juice.
   Few grains salt.

Mix ingredients in order given and freeze.

GRAPEFRUIT ICE.

 ¼ Cup grapefruit juice.
 ¼ Cup water.
 ½ Grain saccharin dissolved in
 ½ Teaspoonful cold water.

Remove juice from grapefruit, strain and add remaining ingredients, and freeze to a mush. Serve in sections of grapefruit.

PURITY CUSTARD.

Egg-white 1
Salt .... ⅛ teaspoonful
Vanilla
Milk .... 100 grams

Beat the egg-white with a fork, add the salt, a few drops of vanilla, and the milk. Mix well. Pour into a custard cup placed in a dish of water, and bake in a moderate oven. Food value: 5 grams of carbohydrate; 7 grams protein; 4 grams fat.

CUSTARD.

Egg 1
Egg-white 1
Salt .... ⅛ teaspoonful
Vanilla
Milk .... 100 grams
Cream .... 30 grams

Beat the egg and egg-whit with a fork. Add the salt, a few drops of vanilla, milk and cream. Mix well. Pour into custard cup placed in a dish of water, and bake in a moderate oven. If desired saccharin may be added. Food value: 7 grams carbohydrate; 14 grams protein; 15 grams fat.

JUNKET.

Milk	100 grams
Cream	35 grams
Junket	¼ tablet
Cold water	1 tablespoonful
Vanilla.	

Heat milk and cream until lukewarm, or 100° F. Dissolve the junket tablet in the cold water. Add the dissolved junket tablet and a few drops of vanilla to the lukewarm milk. Stir quickly several times; pour into custard cups and let stand in a warm place until set; then place in the refrigerator. Food value: 7 grams carbohydrate; 4 grams protein; 10 grams fat.

RASPBERRY JELLY.

Gelatin	2 tablespoonfuls
Cold water	1 cupful
Boiling water	3 cupfuls
Raspberry flavoring	2 tablespoonfuls
Saccharin	1 gram

Soak the gelatin in cold water five minutes. Then add boiling water, raspberry flavoring, and saccharin. Put in a cold place to jell. This jelly need not be reckoned as food.

COFFEE BAVARIAN.

Gelatin	7 grams
Cold water	40 grams
Clear coffee, boiling	100 grams
Saccharin	1 grain
Egg-white	1 gram

Soak the gelatin in cold water. Add the boiling coffee and saccharin. When jelly begins to thicken, fold in egg-white beaten stiff. Chill. This recipe makes one serving. Food value: 4 grams protein.

SPANISH CREAM.

Gelatin	1 teaspoonful
Cold water	1 tablespoonful
Hot coffee and cream or water and cream	6 tablespoonfuls
Egg-yolk	1
Saccharin	
Salt	
Egg-white	1

Soak gelatin in cold water, dissolve in hot liquid, pour mixture on egg-yolk and cook like soft-boiled custard, add saccharin and salt, and pour while still hot on the stiffly beaten white of egg, beating constantly, mould and chill.

ICE-CREAM.

Any of the liquids suggested under jellies may be frozen for ice-cream.

COCOA SHELLS.

Cocoa shells	30 grams
Milk	150 grams

Soak the cocoa shells over night in one cupful of water. Bring slowly to the boiling point. Add the milk, heat, strain, and serve. Saccharin may be added. if desired. Food value: 7 grams carbohydrate; 5 grams protein; 7 grams fat.

CHEMICAL COMPOSITION OF AMERICAN
FOOD MATERIALS.

(From Bulletin No. 28, Revised Edition, by Atwater and Bryant, U. S. Dept. of Agriculture. The figures appearing in parenthesis immediately following the name of foodstuff are the minimum and maximum amount of carbohydrate.)

Foodstuffs	C Average Per cent.	P Average Per cent.	F Average Per cent.
Beef, Cooked:			
Roast as purchased	0	22.3	28.6
Round steak, fat removed, as purchased	0	27.5	7.7
Sirloin steak, baked, as purchased ..	0	23.9	10.2
Loin steak, tenderloin, broiled edible portion	0	23.5	20.4
Beef, Canned:			
Corned beef	0	26.3	18.7
Dried beef, as purchased	0	39.2	5.4
Roast beef, as purchased	0	25.9	14.8
Sweetbreads, as purchased	0	20.2	9.5
Tongue, whole, as purchased	0	19.5	23.2
Beef, Corned and Pickled:			
Corned beef, all analysis	0	15.6	26.2
Tongues, pickled	0	12.8	20.5
Mutton, Cooked:			
Mutton, leg roast, edible portion	0	25.0	22.6
Pork, Fresh:			
Ham, fresh, lean, edible portion	0	25.0	14.4
Ham, fresh, average all analyses, edible portion	0	15.7	33.4
Ham, fresh, visible fat largely removed	0	19.2	16.2
Loin (chops), average all analyses, edible portion	0	16.4	32.0
Ham, smoked, all analyses, edible portion	0	16.5	38.8
Bacon, smoked, all analyses, edible portion	0	10.5	64.8
Sausage:			
Bologna, edible portion	3	18.7	17.6
Farmer, edible portion	0	29.0	42.0
Frankfort, as purchased	1.1	19.6	18.6
Pork, as purchased	1.1	13.0	44.2
Summer, edible portion	0	26.0	44.5
Poultry and Game, Fresh:			
Chicken, broilers	0	21.5	2.5
Fowls	0	19.3	16.3

One gram of fat produces 9.3 calories.

CHEMICAL COMPOSITIONS OF AMERICAN FOOD MATERIALS. (*Continued.*)

Foodstuffs	C Average Per cent.	P Average Per cent.	F Average Per cent.
Poultry and Game, Fresh (*continued*).			
Goose, young, edible portion	0	16.3	36.2
Turkey, edible portion	0	21.1	22.9
as purchased	0	16.1	18.4
Fresh Fish:			
Bass, black, whole, edible portion	0	20.6	1.7
Butter fish, whole, edible portion	0	18.0	11.0
Catfish, edible portion	0	14.4	20.6
Cod, whole, edible portion	0	16.5	0.4
Flounder, whole, edible portion	0	14.2	0.6
Halibut, steaks or sections, edible portion	0	18.6	5.2
Mackerel, whole, edible portion	0	18.7	7.1
Perch, white, whole, edible portion ..	0	19.3	4.0
Salmon, whole, edible portion	0	22.0	12.8
Shad, whole, edible portion	0	18.8	9.5
Shad, roe as purchased	2.6	20.9	3.8
Spanish mackerel, whole, edible portion	0	21.5	9.4
Trout, brook, whole, edible portion .	0	19.2	2.1
Weakfish, whole, edible portion	0	17.8	2.4
Fish, Preserved and Canned:			
Cod, salt, boneless, edible portion	0	27.3	0.3
Halibut, smoked			
Halibut, as purchased	0	19.3	14.0
Mackerel, salt, dressed, edible portion	0	17.3	26.4
Salmon, canned, edible portion	0	21.8	12.1
Sardines, canned, edible portion	0	23.0	19.7
Shellfish, etc., Fresh:			
Clams, long, in shell, edible portion .	2.0	8.6	1.0
Crabs, hardshell, whole, edible portion	1.2	16.6	2.0
Lobster, whole, edible portion	0.4	16.4	1.8
Oysters, in shell, edible portion	3.7	6.2	1.2
Dairy Products, etc.:			
Butter, as purchased	0	1.0	85.0
Buttermilk, as purchased	4.8	3.0	0.5
Cheese, American, pale, as purchased	5.3	28.8	35.9
Cheese, American, red, as purchased .	0	0.0	38.3
Cheese, cottage, as purchased	4.3	20.9	1.0
Cheese, crown brand cream, as purchased	2.2	5.2	58.0
Cheese, Dutch, as purchased	2.2	0.0	17.7
Cheese, full cream, as purchased	2.4	25.9	33.7
Cheese, Limburger, as purchased	0.4	23.0	29.4
Cheese, Neuchatel, as purchased	1.5	18.7	27.4
Cheese, Roquefort, as purchased	1.8	22.6	29.5
Cheese, Swiss, as purchased	1.3	27.6	34.9

CHEMICAL COMPOSITIONS OF AMERICAN FOOD MATERIALS. (*Continued.*)

Foodstuffs	C Average Per cent.	P Average Per cent.	F Average Per cent.
Dairy Products, etc. (continued).			
Milk, condensed, sweetened, as purchased	54.1	8.8	8.3
Miscellaneous:			
Gelatin, as purchased	0	91.4	0.1
Lard, refined, as purchased	0	0.0	100.0
Oleomargarine, as purchased	0	1.2	82.0
Vegetable Food:			
Flours, Meals, etc.			
Barley, meal and flour	72.8	10.5	2.2
Barley, pearled	77.8	8.5	1.1
Buckwheat flour	77.9	6.4	1.2
Buckwheat preparations			
Farina and groats	84.1	4.1	0.4
Self-raising	73.4	8.2	1.2
Corn flour	78.4	7.1	1.3
Corn meal, as purchased	65.9	7.5	4.2
Pop corn	78.7	10.7	5.0
Hominy	79.0	8.3	0.6
Oatmeal	67.5	16.1	7.2
Oatmeal, boiled	11.5	2.8	0.5
Oatmeal, gruel	6.3	1.2	0.4
Oats, other preparations, rolled oats .	66.2	16.7	7.3
Rice	79.0	8.0	0.3
Rye flour	78.7	6.8	0.9
Wheat flour, entire wheat	71.9	13.8	1.9
Wheat flour, gluten	71.1	14.2	1.8
Wheat flour, graham	71.4	13.3	2.2
Wheat flour, prepared (self-raising) ..	73.0	10.2	1.2
Wheat flour, patent roller process, baker's grade	72.7	13.3	1.5
Wheat preparations:			
Macaroni	74.1	13.4	0.9
Noodles	75.6	11.7	1.0
Spaghetti	76.3	12.1	0.4
Vermicelli	72.0	10.9	2.0
Bread, Crackers, Pastry, etc.:			
Bread, brown, as purchased	47.1	5.4	1.8
Wheat preparations:			
Shredded wheat biscuit	76.0	8.3	0.6
Wheatena	76.0	11.3	2.8
Cream of wheat	75.0	11.5	0.9
Cracked wheat	74.0	11.1	1.7
Wheatlet	74.0	12.8	1.6
Quaker wheat berries	72.0	13.8	1.9
Macaroni	74.1	13.4	0.9
Bread, corn (johnnycake) as purchased	46.3	7.9	4.7
Bread, rye, as purchased	53.2	9.0	0.6

CHEMICAL COMPOSITIONS OF AMERICAN FOOD MATERIALS. (*Continued.*)

Foodstuffs	C Average Per cent.	P Average Per cent.	F Average Per cent.
Bread, Crackers, Pastry, etc. (*continued*).			
Bread, rye and wheat, as purchased .	51.5	11.9	0.3
Zwieback, as purchased	73.5	9.8	9.9
Bread, white bread from high-grade patent flour	56.5	8.7	1.4
White bread, from regular patent flour	54.9	9.0	1.3
White bread from baker's flour	48.3	10.6	1.2
White bread from low grade flour ...	44.3	12.6	1.1
Sugars, Starches, etc.:			
Honey, as purchased	81.2	0.4	0
Molasses, cane, as purchased	69.3	2.4	
Starch, tapioca, as purchased	88.0	0.4	0.1
Sugar, coffee, or brown sugar, as purchased	95.0	0	0
Sugar, maple, as purchased	82.8	0	0
Sugar, powdered, as purchased	100.0	0	0
Syrup, maple, as purchased	71.4	0	0
Vegetables, Fresh:			
Asparagus	3.3	1.8	0.2
Artichokes	16.7	2.6	0.2
Beans, butter or green	14.6	4.7	0.3
Beans, lima, fresh, as purchased	9.9	3.2	0.3
Beans, lima, dried	65.9	18.1	1.5
Beans, lima, fresh, edible portion only	22.0	7.1	0.7
Beans, string, as purchased	6.9	2.1	0.3
Beets, fresh	9.7	1.6	0.1
Brussels sprouts	3.4	1.5	0.1
Cabbage (3.0 to 6.5)	5.6	1.6	0.3
Carrots, fresh (5.9 to 11.0)	9.3	1.1	0.4
Cauliflower (3.4 to 6.)	4.7	1.8	0.5
Celery (3.0 to 4.6)	3.3	0.1	1.1
Corn, green (14.1 to 22.6)	19.7	3.1	1.1
Cucumber (2.2 to 4.0)	3.1	0.8	0.2
Eggplant, edible portion	5.1	1.2	0.3
Dandelion	10.6	2.4	1.0
Kohl rabi	5.5	2.0	0.1
Leeks, as purchased	5.0	1.0	0.4
Lettuce	2.9	1.2	0.3
Mushrooms	6.8	3.5	0.4
Onions	9.9	1.6	0.3
Parsnips	13.5	1.6	0.5
Peas, green, edible portion (13.4 to 18.9)	16.9	7.0	0.5
Potatoes (13. to 27.)	18.4	2.2	0.1
Potatoes, sweet (16.5 to 44.5)	26.0	1.8	0.1
Pumpkins (3.9 to 5.9)	5.2	1.0	0.1
Radishes (3.4 to 8.3)	5.8	1.3	0.1
Rhubarb (2.9 to 4.4)	3.6	0.6	0.7

Foodstuffs	C Average Per cent.	P Average Per cent.	F Average Per cent.
Vegetables, fresh (*continued*).			
Sauerkraut (3.3 to 4.4)	3.8	1.7	0 5
Spinach, fresh (3.1 to 3.4)	3.2	2.1	0.3
Squash, edible portion (3.5 to 16.1) ..	9.0	1.4	0.5
Tomatoes (2.2 to 6.5)	3.9	0.9	0.4
Turnips (2.8 to 23.8)	8.1	1.3	0.2
Vegetables, Canned:			
Artichokes, as purchased	5.0	0.5	0.0
Asparagus, as purchased	2.8	1.5	0.1
Beans, baked, as purchased	19.6	6.9	2.5
Beans, string, as purchased	3.8	1.1	0.1
Beans, little green, as purchased	3.4	1.2	0.1
Beans, wax, as purchased	3.1	1.0	0.1
Beans, haricots verts, as purchased ..	2.5	1.1	0.1
Beans, lima, as purchased	14.6	4.0	0.3
Beans, red kidney, as purchased	18.5	7.0	0.2
Brussels sprouts, as purchased	3.4	1.5	0.1
Corn, green, as purchased	19.0	2.8	1.2
Peas, green, as purchased	9.8	3.6	0.2
Potatoes, sweet, as purchased	41.4	1.9	0.4
Pumpkins, as purchased	6.7	0.8	0.2
Squash, as purchased	10.5	0.9	0.5
Succotash, as purchased	18.6	3.6	1.0
Tomatoes, as purchased	4.0	1.2	0.2
Pickles, Condiments, etc.:			
Catsup, tomato, as purchased	12.3	1.5	0.2
Horse-radish, as purchased	10.5	1.4	0.2
Olives, green, as purchased	8.5	0.8	20.2
Pickles, cucumber, as purchased	2.7	0.5	0.3
Pickles, mixed, as purchased	4.0	1.1	0.4
Pickles, spiced, as purchased	20.7	0.4	0.1
Fruits, Berries, etc., Fresh:			
Apples, edible portion	14.2	0.4	0.5
Apricots, edible portion, average	13.4	1.1	
Bananas, yellow, edible portion	22.0	1.3	0.6
Blackberries, as purchased	10.9	1.3	1.0
Cherries, edible portion	16.7	1.0	0.8
Cranberries, as purchased	9.9	0.4	0.6
Figs, fresh, as purchased, average ...	18.8	1.5	
Grapes, edible portion, average	19.2	1.3	1.6
Huckleberries, edible portion	16.6	0.6	0.6
Lemons, edible portion	8.5	1.0	0.7
Lemon juice	9.8		
Muskmelons, as purchased	4.6	0.3	
Nectarines, as purchased	14.8	0.6	
Oranges, edible portion	11.6	0.8	0.2
Peaches, edible portion	9.4	0.7	0.1
Pears, edible portion	14.1	0.6	0.5
Pineapple, edible portion	9.7	0.4	0 3

CHEMICAL COMPOSITIONS OF AMERICAN FOOD MATERIALS.   (*Continued.*)

Foodstuffs	C Average Per cent.	P Average Per cent.	F Average Per cent.
Fruits, Berries, etc., Fresh (*continued*).			
Plums, edible portion	20.1	1.0	
Pomegranates, edible portion	19.5	1.5	1.6
Prunes, edible portion, average	18.9	0.9	
Raspberries, red, as purchased	12.6	1.0	
Raspberries, black, edible portion	12.6	1.7	1.0
Strawberries, edible portion	7.4	1.0	0.6
Watermelons, edible portion	6.7	0.4	0.2
Whortleberries, as purchased	13.5	0.7	3.0
Nuts:			
Almonds, edible portion	17.3	21.0	54.9
Brazil nuts, edible portion	7.0	17.0	66.8
Butternuts, edible portion	3.5	27.9	61.2
Chestnuts, fresh, edible portion	42.1	6.2	5.4
Cocoanuts, edible portion	27.9	5.7	50.6
Filberts, edible portion	13.0	15.6	65.3
Hickory nuts, edible portion	11.4	15.4	67.4
Peanuts, edible portion	24.4	25.8	38.6
Peanut butter, as purchased	17.1	29.3	46.5
Pecans, polished, edible portion	13.3	11.0	71.2
Walnuts, California, edible portion ..	13.0	18.4	64.4
Walnuts, California, black, edible portion	11.7	27.6	56.3
Walnuts, California, soft shell, edible portion	16.1	16.6	63.4
Miscellaneous:			
Chocolate, as purchased	30.3	12.9	48.7
Cocoa, as purchased	37.7	21.6	28.9
Cereal, coffee, infusion (1 part boiled in 20 parts water)	1.4	0.2	4.0
Yeast, compressed, as purchased	21.0	11.7	

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Diseases of the Respiratory Tract

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Diseases of the Respiratory Tract.

FOREWORD.

THE lungs have long held an important place in medical history, the greatest significance being attached to this portion of the body. Some of the older writers held the view that in the lungs was located the function of prolonging life, that longevity was dependent upon this structure. Even today the diseases of the lungs, especially the infectious diseases such as pneumonia and tuberculosis, are responsible for a very large proportion of the deaths of all ages. The aged, and those suffering from chronic disease, being so frequently carried off by pneumonia that this disease has been called "the old man's friend."

There are numerous diseases of the lungs and bronchi of a chronic nature which, while not so frequently fatal, are oftentimes responsible for a state of semi-invalidism in later life, rendering the aged incapable of performing their full amount of mental or physical work. Many of these diseases develop so insidiously and slowly that they become well-established before attracting the attention of the patient, at least sufficiently to warrant his seeking medical advice. We have attempted in the following pages to call attention to the diseases which we believe are most important and have tried to describe their earlier manifestations in such a way that they may be more readily recognized before becoming fully developed.

Before taking up a consideration of the diseases themselves it appears advisable to call attention to the employment of forced respiratory exercises. The laity have been imbued with the idea that a valuable method of retaining their health is to employ one of the deep-breathing exercises which have been strongly recommended by a number of popular writers. While these authors have described many varied methods of

securing their purpose, they possess the common object of forced, deep breathing. While there can be no question that a prime essential for a healthy state is to have every organ functioning properly, and therefore, it is important that an individual should breathe correctly, the claims of these writers are so very extravagant that one naturally wonders what is the truth in regard to this question. The city dweller whose work is of a sedentary nature would undoubtedly be improved by some set of exercises which have for their object the proper aëration of the blood, although it has not been very clearly shown that to attain this object it is necessary to increase the expansion of the chest to the degree urged by so many of these enthusiasts.

Anyone who has had the opportunity of seeing many advanced tuberculosis patients cannot help but have been impressed with the large number of them who may live for months and even years with only a relatively small portion of the lungs functioning, provided they remain at rest. In fact, many of these cases with only a very small amount of air-bearing lung tissue left will not even complain of shortness of breath, provided they make no excessive demands upon the respiratory organs. If life may be comfortably maintained with such a small portion of the air-bearing tissue of the lung, one may readily question the necessity of any attempt to increase the air capacity in the average individual whose lungs are intact, provided he is not going to require an unusual capacity to meet extraordinary demands, as in singing, running, etc. There can be no question that there are, on the other hand, a certain proportion of individuals who might be improved generally by some form of breathing exercises, especially those persons who have a faulty chest development, the result of some obstruction to breathing in childhood, or as a sequel to some faulty postural habit. There are a number of people who, through carelessness, lack of exercise, etc., have never learned to breathe properly or correctly, who would also come under the group of those who might be benefited by this measure.

A word of caution might not be amiss as to the possible dangers which may attend these deep-breathing exercises in certain individuals, namely, those with quiescent or incipient

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pulmonary tuberculosis. Time and again it has been my
misfortune to see patients in whom a beginning tuberculous
process in the lungs has led them of their own accord, or
occasionally on the advice of someone else, to take forced
deep-breathing exercises, with the result that the partly dor-
mant lesion has been transformed into an active, rapidly
spreading process. For the actually tuberculous lung, rest is
an absolute essential for recovery, and it is incumbent upon
anyone who recommends deep-breathing exercises to use
every effort to first determine whether there is any evidence
of pulmonary tuberculosis present. For the patient with
arrested disease or signs suggesting moderate or extensive
fibrosis, this method of treatment must be employed with
the greatest caution.

There is one method of securing proper aëration of the
blood without any special effort on the part of the individual
and without the slightest risk, and that is by means of fresh
air, both by day and by night, for both the sick and the well.

With this brief reference to the hygiene of the lungs, we
will proceed to consider the various diseases which may ef-
fect the lungs, which for convenience we have grouped under
the following headings:

Chronic Bronchitis.
Bronchiectasis.
Emphysema.
Pneumoconiosis.
Pulmonary Fibrosis.
Fibroid Tuberculosis.
Syphilis of the Lungs.
Malignant Disease of the Lungs, Pleura and Mediastinum.
Chronic Inflammation and Abscess of the Lung.

DISEASES OF THE BRONCHI.

There are a number of diseases which might be included
under this heading if it was our purpose to attempt a dis-
sertation covering every possible disease of these structures.
We feel, however, that many of these conditions, owing to
their rarity or close relationship to other processes, might
with advantage be omitted. There are several conditions,

such as asthma, asthmatic bronchitis and fibrinous bronchitis, which have been covered by Dr. T. Chandler Walker in another section (pages 839 to 881). We have also ignored the acute types of bronchitis and the numerous subdivisions of the chronic form employed by some authors as being without special value and serving no useful purpose in a work of this kind.

CHRONIC BRONCHITIS.

It is with the greatest hesitation that I have employed the above heading for this section of my subject, as there is probably no medical term which has been more loosely employed to cover lack of care in the study of the patient, or ignorance of pulmonary disease and the proper methods for its recognition. The term chronic bronchitis has been laxly applied, at some time or another, to probably every disease which may affect the bronchi or lungs, either directly or indirectly. This custom has been so general that one meets constantly with patients of middle life who hold the firm belief that a certain amount of cough and expectoration is perfectly normal in individuals who have reached that time of life, and that it is perfectly compatible with good health.

Chronic bronchitis is almost invariably merely a symptom and not a disease, and should be so looked upon by every medical man. The diagnosis of chronic bronchitis should only be permitted to stand in those cases in which every resource has been exhausted to eliminate the probability of any underlying disease being present, both in the study of the lungs themselves and of the other organs of the body. The absurdity of applying therapeutic measures to a chronic bronchitis as such when it may be merely a symptom of renal, cardiac, or pulmonary disease, is readily apparent, and there are certain forms of this disease—true chronic bronchitis—which may be the result of some type of inhaled irritant, such as smoke, dust, etc., rather than some disease process in the body, which will only respond to treatment when the causative factor has been eliminated.

In the following pages we will consider under the heading of Chronic Bronchitis only those cases which are not dependent upon other disease of the lungs or other organs of

the body—that relatively small group in which a chronic cough persists without any obvious associated process. Before taking up our consideration of this disease, it might not be amiss to enumerate some of the more common chronic diseases which should be looked for in any patient presenting signs and symptoms of chronic bronchitis. It may seem superfluous to call attention to such diseases as tuberculosis, syphilis, emphysema, fibrosis, tumors, foreign bodies in the bronchi, enlarged bronchial glands, abscess, chronic pulmonary infections, and bronchiectasis, and yet they are not infrequently overlooked. Cardiac disease, renal disease, arterial hypertension, aneurism, alcoholism, gout, aortitis, and chronic infection of the upper air passages, are by no means uncommon causes which are not so obviously connected with the bronchitis.

The term chronic bronchitis is employed for this disease, but more frequently the manifestations or symptoms are not continuous, being characterized by repeated attacks of the condition, especially in the winter months, with intervening periods during which all evidence of the trouble may disappear. The disease is an important one and should not be lightly viewed, as even if not the result of other disease the persistence of the condition may result in the development of emphysema with its attendant discomforts, or it may pave the way for serious infection of the lungs which may even prove fatal.

With the object of prolonging life and rendering the later years of the individual more comfortable and worth while, it is essential that during middle life every case of acute bronchitis which does not readily clear up or tends to recur, or any patient who gives a history of frequently repeated attacks of cough or expectoration, should be subjected to a most thorough and exhaustive examination of the entire body to eliminate the possibility of any other disease being present, special attention being paid to the lungs, heart, kidneys and upper air passages.

There are no peculiar pathological changes involved which require any minute description here, as the disease merely consists in an inflammatory process of the mucosa of the bronchi, which is almost invariably sooner or later dependent

upon some form of infection. The changes in the mucous membrane are characterized by thickening, reddening and ulceration, with occasionally complete denudation. The bronchial and peribronchial infiltration which is usually present may be replaced by fibrous tissue.

The signs and symptoms vary with the severity and extent of the process, consisting in cough, expectoration, more or less distress or actual pain in the chest, frequently substernal, or over the lower costal margins, and usually accompanied by dyspnea. The expectoration varies in amount from an ounce to five or six ounces a day, while in some cases the amount of material expectorated may be profuse, the character of which varies from an almost pure mucus to a definitely purulent material. There is no special diagnostic feature to be found in the expectorated material, except of a negative character such as a total absence of elastic tissue, and the lack of any bacterial content peculiar to this disease.

The physical signs are characterized by the finding of a number of râles which are especially marked toward the roots of the lung, from which points they radiate out toward the periphery, being more frequent, as a rule, over the lower portion of the lungs. The râles are not constantly present, but usually vary from time to time in their presence, number and intensity. The râles differ greatly in their quality, and while most frequently are of the type known as "large moist," may be of almost any variety.

The treatment of this disease is valueless unless directed toward the relief of the underlying condition when such is present. Special efforts should be made to secure a normal condition of the upper air passages, especially by the correction of infected tonsils or any nasal obstruction that may be present. Considerable relief may be obtained by such hygienic measures as will improve the general tone and resistance of the individual, such as bathing, exercise, change of climate, clothing, rest, fresh air and diet.

The medication directed toward the relief of the cough and expectoration will be largely determined by the character of the cough and the amount and appearance of the expectoration. When the cough is persistent and harassing, with lit-

tle or no expectoration, the sedative or depressant expectorants like antimony, ipecac and apomorphin are indicated. When the expectoration is scanty or tenacious, drugs like ammonium chloride, squills, senega, may be employed with advantage. Potassium iodide in small doses will also occasionally be found very useful. When the expectoration is profuse and purulent, creosote and terpin hydrate are the drugs which will give the best results. A popular formula for relieving the morning cough is: 15 grains sodium bicarbonate, 5 grains sodium chloride, and 5 minims spirit of chloroform in anise water, added to an equal quantity of hot water and taken before rising in the morning. Two to 5 grains myrtol, in gelatin capsules, three or four times a day, has been recommended if fetor is present, also oil of cloves in emulsion.

Counterirritation to the chest with mustard plasters, tincture of iodin, liniments, etc., will be found useful in most cases. Steam inhalations of compound tincture of benzoin will also prove helpful. Inhalations and intratracheal injections may rarely be of value, but sprays of liquid petrolatum containing small quantities of menthol and camphor will not infrequently afford relief from harassing coughs.

Tonics are of considerable value especially in individuals who are below par, the most useful being iron, quinin, strychnia and arsenic. Codliver oil is a drug which will be found most useful in the treatment of these cases, as evidenced by an improvement in nourishment and strength, and not infrequently by a cessation of the cough and expectoration.

BRONCHIECTASIS.

Bronchiectasis only extremely rarely occurs as a primary disease, being almost always secondary to some other process, such as pulmonary tuberculosis, pulmonary fibrosis, pneumoconiosis, compression of the lung, or thickened pleura; or it may result from some obstruction to the bronchi, such as cicatricial contraction, foreign body or pressure from without. Cases have been reported in which the condition has developed in the course of chronic bronchitis, with or with-

out emphysema, giving rise to the view that possibly there are certain individuals in whom it may occur as the result of some peculiar deficiency in the bronchial walls.

The disease occurs in two forms, according to the pathological anatomy, the cylindrical and the saccular or globular. While an acute form has been described, it is the chronic type which possesses the greatest clinical interest. The disease may develop in childhood, but it is in adult life that it reaches its most marked development. While it cannot be considered as a frequent disease, it probably escapes recognition in many instances, being viewed simply as chronic bronchitis when not very great in extent, or with only a moderate dilatation of the bronchi.

The symptoms are similar to those of chronic bronchitis, although in these cases the cough is usually more paroxysmal in character and accompanied by the expectoration of profuse purulent material, which is frequently offensive. In the intervals between the coughing spells, which occasionally may be of twenty-four to forty-eight hours duration, the patient may be entirely free of all evidence of cough or expectoration. Change of posture, as in lying down, or some unusual exertion, such as physical exercise, laughing or sneezing, may bring on the attacks of expectoration. Sooner or later the expectoration becomes exceedingly fetid, the odor being most nauseating in many instances, and even the breath may have the most offensive odor. The material expectorated, which tends to separate into three fairly distinct layers on standing, varies in quantity according to the extent of the lesion and the length of the interval between paroxysms, at times being excessive, 25 to 30 ounces in the twenty-four hours. In extreme cases the amount brought up during these paroxysms may be so excessive as to almost suffocate the patient with the sudden outpouring of the large quantity of purulent material.

In the more advanced cases hemoptysis may occur, even at times being excessive in quantity. The presence of fever varies, usually when present not being very high or of any definite type. There is one symptom, however, which is so frequent that it possesses considerable diagnostic value and that is clubbing of the fingers and toes. While this hyper-

trophic pulmonary osteoarthropathy occurs in a number of other conditions, such as congenital cardiac disease, chronic pulmonary tuberculosis, empyema of long standing, and sim- ilar conditions, it is in bronchiectasis that some of the most marked cases have been observed. The thickening of the distal phalanges of the fingers and toes, and rarely also of the radius and tibia, results in the characteristic and usually very striking appearance of this disease.

The physical signs upon which a diagnosis of bronchi- ectasis may rest are extremely difficult to define, as the dis- ease varies to such an extent in its distribution, characteris- tics, and location, and is so frequently associated with other changes in the lungs that no very definite description can be outlined. In the majority of cases the diagnosis must rest upon the symptoms which suggest the presence of this con- dition, such as copious expectoration at irregular or regular intervals, etc.

When the symptoms as described above arise in a patient suffering from chronic pulmonary tuberculosis, especially of the fibroid type, or pulmonary fibrosis due to other etio- logical factors, one may reasonably infer that bronchiectasis is present, even in the absence of any characteristic physical signs.

When present the physical signs are merely those of a cavity, when the contents have been expelled, tympany, cav- ernous or bronchial breathing and occasionally whispering pectoriloquy being noted. If the cavity is filled with fluid, dullness, absence of breath sounds, and bubbling metallic râles may be present. The most characteristic sign in all cases is the finding of bubbling metallic râles, which suggest by their character and quality that they arise in a space which is larger than the normal bronchus in that part of the lung. This sign is especially valuable when detected over the lower portion of the chest, a not uncommon site for bronchiectasis, as when arising in the upper chest the signs may suggest the presence of a cavity resulting from pulmonary tubercu- losis.

It will be seen that the signs are not peculiar to this condition and it may be impossible to determine from the physical examination alone whether one is dealing with a

bronchiectatic cavity or one due to pulmonary tuberculosis, chronic abscess, or an old empyema opening into a bronchus. The cause of the bronchiectasis is not always easy to discover, for while tuberculosis is one of the most common, and pulmonary fibrosis by no means rare, occasionally the dilatation will be due to syphilis, foreign body in the bronchus, aneurism or mediastinal growth, and in a certain proportion of cases the bronchiectasis will occur without any discoverable cause.

The x-ray will prove of the greatest value in ·naking a final diagnosis in many cases, although in a certain proportion of cases this method of examination will be disappointing. Stereoscopic plates will frequently assist in the determination of the etiological factor, as outlined in the preceding paragraph.

The presence of bronchiectasis should always be suspected in cases with chronic fibroid disease of the lungs, or in patients suffering from chronic cough and expectoration without any evident pulmonary changes. The probability of this condition being present becoming more likely when the patient suffers from cough and profuse expectoration which occurs in spells, with intervals between in which he is free of both. When the expectoration is fetid in character, with clubbing of the fingers and toes, the diagnosis becomes almost absolute.

The patient suffering from bronchiectasis may live with a fair amount of comfort for many years, provided the lesion is not very marked or very extensive, but when the disease has progressed to such an extent as to produce well-marked symptoms and signs it almost invariably exerts a most unfavorable influence upon the strength and well-being of the patient, frequently reducing him to a state of semi-invalidism or even actually causing his death. Cases are not uncommon in which the odor of the breath is so foul as to compel the patient to live a life of isolation.

Death may rarely result from hemorrhage, degenerative changes in the various organs of the body resulting from the prolonged toxemia or from secondary infectious processes in the lungs. Not uncommonly brain abscess or meningitis may cause death in these individuals, probably as the result of metastasis by septic emboli.

The treatment of these cases is unfortunately most discouraging if not recognized in the early stages, even at best treatment is largely ameliorative. The line of treatment suggested for chronic bronchitis should be persistently and actively used in these cases. Creosote, terpin hydrate, oil of cloves, copaiba, oil of santal, eucalyptus, the balsams and resins, will be the drugs which promise the greatest amount of relief of any medication applied by the mouth. Creosote vapor baths, intratracheal injections of various remedial agents, inhalations, and sprays of all kinds have from time to time been recommended.

Postural exercises have been employed with advantage in cases in which evacuation of the contents of the cavity takes place infrequently. Some of these cases may secure complete evacuation at frequent intervals, with a resulting favorable influence upon the process, by assuming a position at fixed periods which will favour complete drainage, such as by lying on one side or the other, assuming the Trendelenberg position, or hanging suspended from the hips over the foot or side of the bed with the head resting on or near the floor.

Bacterial vaccines may be employed, as favorable results have been claimed by some observers in a small proportion of cases, but too much must not be anticipated from this method of treatment.

Artificial pneumothorax has given good results in some cases in which the process was not associated with extensive disease of the lung itself, and where the pleural surfaces had not become adherent, and in selected cases this method of treatment should be seriously considered. When the process is confined to a restricted portion of the lower lobes, amputation has been successfully performed in a few cases, but surgical intervention should not be lightly advised and never considered unless it can be performed by a surgeon who has had considerable experience in this line of work.

SUMMARY.

The diseases of the bronchi occurring in middle life must not be looked upon lightly or considered insignificant, as in many instances this may be the first indication of serious

disease in other parts of the body, marked changes in the lung structure, or even important processes in the bronchi themselves. The full duty of the physician is not fulfilled in attending any patient suffering from chronic cough or expectoration until he has eliminated every possible etiological factor by every method of study available. When compelled to finally make a diagnosis of chronic bronchitis of unexplained origin the treatment should not be carried out perfunctorily but every possible means should be resorted to in the effort to secure relief.

The number of sufferers in old age from diseases of the respiratory tract, causing them to be bed-ridden or confined to the house throughout the greater portion of the year, would undoubtedly be materially reduced if "chronic bronchitis" was not so generally looked upon as an unimportant or possibly unavoidable accompaniment of advancing years. To pursue the subject further it is highly probable that a proper appreciation of the possible seriousness of this condition would result in the prolongation of life by reducing the mortality from pneumonia in later life, a disease which at the present time takes such a terrible toll among those past middle age.

EMPHYSEMA.

The term emphysema is usually applied to the hypertrophic, large-lunged, diffuse vesicular variety of this disease. There are other forms which have been termed senile or atrophic emphysema, compensatory emphysema and interstitial emphysema. Compensatory emphysema and interstitial emphysema are not true emphysema, the former being merely a simple pulmonary over-distension to replace a loss of the air-bearing property of other portions of the lung, and the latter an escape of air into the interstitial tissues of the lung. We will, therefore, confine our consideration to the diffuse vesicular and senile forms.

DIFFUSE VESICULAR EMPHYSEMA.

The pathological changes resulting from this disease are not without interest from the diagnostic standpoint and may be briefly reviewed with advantage. The lungs are large and

pale, showing the markings of the ribs, the pulmonary margins are rounded and blunt, the edges almost completely overlapping the heart, the apices extending well above the clavicles and the anterior margins frequently meeting in the middle lines, and they usually extend down low so that the dome of the diaphragm is flattened. The lungs do not collapse when the thorax is opened, owing to their loss of elasticity. On section the surface is dry and pale, the alveoli appearing dilated. In well marked cases vesicles or bullæ may be seen scattered over the surface of the lung beneath the pleura, or on the cut surface. These vesicles vary in size from a pinhead to a pea, or may even be as large as an egg when several of them coalesce. The alveolar dilatation is most marked over the upper and anterior surfaces of the lung, much less commonly posteriorly, and seldom invades the central portion. Microscopically the alveoli are found to be definitely enlarged, with their walls atrophied, the rupture of these walls accounting for the presence of the vesicles noted in the gross specimens. This thinning of the walls is accompanied by the obliteration of constricted vessels with a consequent reduction of the blood supply. The elastic fibers appear to be diminished in size and number, although it is a question whether this reduction is an actual or merely an apparent one.

Evidence of a chronic bronchitis is almost invariably present, with not infrequently a dilatation of the bronchi. The right heart is usually hypertrophied and dilated as the result of the impeded pulmonary circulation.

A number of theories have been advanced to account for the development of this disease, the most reasonable being what is known as the expiratory theory, which briefly may be summarized as follows: Given an obstruction to the passage of air, during inspiration which is a more forcible movement, air is drawn into the alveoli, expiration being more passive in nature does not expel all the air from the vesicles before more air is forced into the lung by inspiration, resulting in over-distention of the alveoli. Long continued cough may result in bringing about almost the same set of changes, as during cough the glottis is closed and forcible expiration against this point of resistance may bring about a distention

of the alveoli. A number of writers have insisted that for these factors to bring this about it is essential that some anatomical abnormality be present, either in a lack of elastic tissue or in calcification of the costal cartilages, the lack of elastic tissue being believed by some to be a hereditary deficiency.

The most common cause for emphysema is undoubtedly chronic bronchitis, which in some instances may result from dust inhalation. The lifting of heavy weights has been given as a cause of this disease, as has also the playing of wind instruments, although this latter opinion lacks confirmation. Many believe that chronic bronchitis is merely the exciting factor in producing emphysema in a lung which is already defective. Asthma is also frequently a factor in bringing about this change in the lungs.

The process consists of two essential conditions, thinning of the walls and dilatation of the air vesicles, but it is uncertain which is the primary condition, although the evidence is in favor of the dilatation (the mechanical theory) being the primary factor. It must be acknowledged that a large number of cases occur in individuals without any evident cause.

Emphysema is especially a disease of middle life, or at least it is during this period that it becomes most evident, about sixty-eight per cent. of cases occurring between the ages of thirty and sixty years.

The symptoms vary with the degree of over-distention, the condition of the heart and the severity of the bronchitis, which is almost a constant accompaniment to the emphysema. The most frequent symptom and usually the earliest, is the presence of dyspnea, which may at first only be noticed on exertion, but later becomes constant and extreme. The dyspnea is partly—and in the early stages, solely—the result of the loss of elasticity of the lung, but later may be due to decreased aërating surface in the lung, dependent upon the thinning of the alveolar walls and obliteration of vessels and capillaries. Cyanosis is a very common symptom of emphysema, and in some cases may be extreme, even before the cardiac dilatation and weakness of the later stages develops.

While cough may possibly be absent, it is almost invari-
ably present, accompanied by varying amounts of expec-
toration. Owing to the defective expulsive power in these
cases, the cough may be of the most violent, paroxysmal
character, and frequently consists of a series of short expira-
tory jerks. The disease throws a considerable strain on the
right side of the heart which may result in dilatation, and
thus the later stages of the disease may be complicated by
the symptoms due to the cardiac weakness.

The diagnosis of this disease in the more advanced stages
does not as a rule demand any special diagnostic ability, the
majority of the cases being readily recognized on inspection
alone. During the early stages the recognition of the process
is frequently far from easy and may call for every resource
at the command of the examining physician.

The more marked cases present a clinical picture which is
fairly typical. On inspection the patient is almost invariably
seen to be cyanotic, the breathing labored and rapid, with
short respiratory excursion, the accessory muscles of expira-
tion being brought into play. The thorax is enlarged and
gives the appearance of being fixed in a state of permanent
inspiration, the increase in the anteroposterior diameter
which makes the chest cylindrical in shape, together with the
constriction below the costal margins results in forming the
"barrel-shaped" chest, which is the descriptive title so fre-
quently mentioned as being present in this disease. The
costal angle is more obtuse than normal owing to the flaring
of the lower margins of the ribs. The head is usually bent
forward, with rounding of the shoulders, the neck is short,
the sternum prominent, and respiration is accompanied by
an up and down movement of the sternum with very slight
general expansion of the chest, in spite of the extraordinary
respiratory efforts. The superficial veins are unusually
prominent, and not infrequently the jugular veins are dis-
tended and bulging. Epigastric pulsation is also commonly
noted on account of the cardiac dilatation and the lowered
position of the diaphragm. In the advanced stages clubbing
of the fingers and toes may be present.

It will be seen that the signs on inspection are in a large
part due to the change in the size of the lungs, the respira-

tory phenomena subsequent to the alteration in the quality of the lung, and to the resulting circulatory disturbances.

Palpation reveals little if any additional information of special value. Vocal fremitus may be reduced but is frequently unchanged, the apex-beat of the heart is, as a rule, not palpable, and the signs detected by inspection may be confirmed by this method of study. The pulse is, as a rule, small and steady and the blood-pressure low.

Percussion gives information of the greatest value, especially in those cases in which the inspection of the patient reveals little characteristic change in the general appearance of the patient or shape of the chest. By this method of examination one may detect the pulmonary changes by the hyperresonant booming note over the entire chest, and the increase in the size of the lungs by their extension above the clavicles, the absence of absolute cardiac dullness, and the extension downward of the lower pulmonary margins. In some cases the lowering of the upper margin of liver dullness on the right side may be recognized. The hyperresonance in well-marked cases may at times extend beneath the sternum, owing to the bulging forward of the anterior margins of the lungs which may meet in the median line.

On auscultation the breath sounds are usually very feeble, expiration may be inaudible or extremely soft and markedly prolonged, even three or four times as long as inspiration. The signs detected by this method of examination are usually obscured by the rales produced by the generalized bronchitis which is almost invariably present.

There are several methods of study which may be employed to confirm the physical findings or to provide additional information of value in the diagnosis. Mensuration of the chest will reveal the diminished expansion with exactitude, many of the cases showing an expansion of only one or two centimeters instead of the normal of about seven centimeters. The study of the outline of the chest by means of the cyrtometer will demonstrate the increase in the anteroposterior diameter of the chest, and is of value as providing a permanent record for comparison with later studies. Fluoroscopic examination of the chest by means of the x-ray may reveal the lessened convexity of the diaphragm and the diminished

inspiratory and expiratory changes in pulmonary density. The position and size of the heart and large vessels may be also determined in this way to advantage, as the increase in size of the lungs interferes with their study by means of percussion, and this method may occasionally reveal an underlying, unsuspected pulmonary disease which has been masked by the over-distended lungs.

The process is an important one as it may cause a great deal of discomfort to the individual affected, serious interference with his ability to work, and may lead to cardiac changes which may threaten life itself. In spite of the seriousness of its nature and in spite of the fact that it is not an uncommon disease, it has attracted relatively little attention and study. The discouraging results from treatment when it has become well developed and the difficulty of recognizing it in its early stages may account to some extent for this apparent lack of interest on the part of the medical profession.

The early diagnosis of the disease, with any degree of accuracy, is attended with many difficulties and yet there are a few signs, the presence of which during an examination should suggest the possibility of the presence of this disease at a time when treatment might be of value. In the examination of any individual, but especially those adults who give a history of repeated attacks of bronchitis or in which there is evidence of a diffused generalized bronchitis of varying duration, the greatest care should be exercised to direct the attention to the study of those signs which might be suggestive of the presence of emphysema. This is especially to be desired in those individuals giving a history of dyspnea on exertion or with cyanosis, in whom there is an absence of any evidence of cardiac, vascular or renal change to account for the symptoms.

The signs which might be looked for are, hyperresonance on percussion, prolongation of the expiratory murmur, slight diminution in the respiratory movement, or increase of the anteroposterior diameter of the chest. The signs which should be especially investigated are those which would indicate an increase in the size of the lungs as revealed by an extension forward and downward of the anterior and lower

borders of pulmonary resonance. On the left side this may be best detected by a study of any diminution of the so-called "absolute cardiac dullness," which might better be termed an increase of pulmonary resonance in the region of the heart. The extension downward of the pulmonary resonance may be more easily recognized on the right, as we have the liver dullness which provides a definite contrast for comparison with pulmonary resonance. To be of value, however, it is essential that one be thoroughly familiar with the correct method of percussion to determine the borders of pulmonary resonance, and that one be fully acquainted with the normal limits of the lung in this area.

That portion of the lung which overlies the liver anteriorly, in the normal individual, is exceedingly thinned out, forming a very acute angle. The use of heavy percussion in this region absolutely destroys the value of this method of study, as the dullness of the underlying liver interferes with the note obtained. It is only possible to detect the lower limit of the lung anteriorly by employing the very lightest percussion, proceeding from above downward until the absolute dullness of the liver is reached. This should be performed during ordinary respiration, marking the beginning of dullness with a pencil. The accuracy of the determination of pulmonary limitation may be confirmed by continuous light percussion over the upper limit of absolute liver dullness, and having the patient take a deep inspiration while this is performed. As the lower anterior margin of the right lung moves downward over the liver, during deep inspiration the note will change from dullness to resonance, if the percussion is properly executed. By repeating this procedure zone after zone downward, a point will finally be reached where dullness persists even after deep inspiration. By marking this point also with a pencil one may readily determine the total expansion of the pulmonary margin at that point. By carrying out this method of study around the chest one may readily obtain two lines, indicating the limit of the lung at rest and on deep inspiration which may readily be compared to the normal limits as described in the numerous text books. While this may also be carried out on the left side, the absence of absolute dullness below the lung does not provide

such a distinct contrast and therefore it requires more care and experience to determine the pulmonary border than is the case on the right side. The study of pulmonary resonance in the region of the heart is therefore to be recommended as providing on the left side a more accurate method of estimation.

This method of study has been given in more detail than would appear necessary, but I have felt that this procedure has not been sufficiently emphasized in the past, and that valuable information may thus be obtained which cannot be secured in any other readily available way.

By the use of this method it is possible to demonstrate in the emphysematous patient that the lungs not only extend downward but that their edges are thickened or rounded, as revealed by the more striking contrast on fairly deep percussion between the zone of pulmonary resonance and the liver dullness, than can be found in the patient with normal lungs. The thickening of the lower anterior margin of the lung is more marked owing to the diminished convexity of the diaphragm.

The treatment of emphysema must be chiefly and primarily directed toward the correction of chronic bronchitis (q.v.) which is usually present and which tends to aggravate the pulmonary disease. In those cases in which there are signs or symptoms suggesting the presence of a beginning emphysema it is essential that they avoid any occupation or pursuit which throws any unusual strain upon the lungs or which involves exposure to dust, smoke or fumes. It is advisable to caution even previously healthy individuals to refrain from anything which calls for violent respiratory effort for some time after recovering from pneumonia or acute bronchitis, as instances have been recorded where a neglect to follow this advice has resulted in the rapid development of emphysema.

The patient who is suffering from this disease should adhere rigidly to such hygienic measures as will help to maintain their general health at the highest possible level. Special attention should be given to the digestive tract, as the failure to properly digest the food, especially if it results

in gaseous distention of the stomach or intestines, will add greatly to the discomfort of the patient.

It is unfortunate that we have no definite measure which can be applied to the relief of the pulmonary process itself. The various mechanical devices for assisting in respiration have so far proven without definite value, and the appliances for diminishing the resistance to expiration by having the patient breathe into rarefied air, like Waldenberg's apparatus, while occasionally giving relief for a short time, are without value insofar as cure is concerned and are not usually accessible. Complete immersion of the patient in a compressed air chamber has been claimed to have been followed by beneficial results in the hands of some observers, but their doubtful value and awkwardness in application have caused these mechanical devices to be seldom, if ever, employed at the present time.

Oxygen inhalations may be of value in the advanced cases with extreme cyanosis, and in those cases threatened with cardiac failure from over-engorgement of the right heart bleeding has been employed with relief.

The measures which are of the most value in these cases are those directed toward the relief of the bronchitis and such symptoms as are amenable to treatment.

ATROPHIC OR SENILE EMPHYSEMA.

The atrophy of the lungs in these cases is merely a part of the general wasting process incident to age. The symptoms are, as a rule, much less marked than in the hypertrophic form, dyspnea is usually not so disturbing, and the disease is rarely complicated by bronchial asthma, although the cough may be paroxysmal and so severe as to suggest the presence of this disease.

The patients usually present the withered, emaciated appearance so common in the elderly. The signs incident to venous obstruction, such as cyanosis and clubbing of the fingers, change in the size and shape of the heart, are all absent. The barrel shape of the chest is present but more as a result of the lateral contraction of the chest than by an increase in the anteroposterior diameter as in the other form. The atrophy of the lungs is followed by a greater obliquity

of the ribs, increase in width and depth of the upper anterior interspaces, while the lower ribs tend to approximate each other and even overlap. Respiration is accompanied by an up and down movement of the chest wall and inspiration is shallow.

The note on percussion is hyperresonant and is claimed to be more tympanitic in quality than in the large lunged type. We also find in these cases that all the signs indicative of enlarged lungs are lacking, such as decrease in area of absolute cardiac dullness, etc. The signs on auscultation closely resemble those found in the type previously described, except here the expiration is not prolonged to the same extent. The treatment differs in no way from that previously described.

PNEUMOCONIOSIS.

The inhalation of dust of various kinds results in the development of pulmonary affections which have been grouped under the title of pneumoconiosis. The conditions arising from definite forms of dust inhalation have been given titles which indicate the character of the particular variety of dust, such as anthracosis for that due to coal dust, siderosis for that due to iron dust, and chalicosis for flint dust, etc. There are also a number of popular names which have been applied to these conditions according to the nature of the occupation responsible for the dust inhalation, such as "miners' asthma," "grinders' asthma," "grinders' rot," "potters' rot," etc.

The effect upon the lungs varies with the character of the dust inhaled, the severity of symptoms and signs being in direct proportion to the sharpness and hardness of the dust particles, and to the length of time during which the individual has been exposed. The organic dusts may be said to produce no very marked disturbance of the lungs beyond a moderate degree of bronchitis, although this bronchial disturbance may be very severe and resistent to treatment as long as the individual continues the work which is responsible for the condition. This is probably especially true among workers exposed to the inhalation of hair, such as fur-workers, felt-workers (hatters), etc.

The more serious changes met with are among those exposed to inorganic dusts. This is met with most frequently among coal miners, more particularly those that work in hard coal, being most marked among those that work underground. City dwellers almost invariably show the presence of a moderate degree of anthracosis, especially in those communities that are exposed to an excessive amount of smoke and soot.

There are numerous occupations which are peculiarly liable to various forms of dust inhalation of other kinds than coal dust, the sharp angular particles of flint or silex being the etiological factor in such occupations as pottery, stone masonry, stone quarry work, South African gold mining, etc. Fine particles of iron may also be a factor in such trades as gold-beating, looking-glass making, glass polishing, iron grinding, polishing, etc. Crushed slag may produce a peculiar form of pulmonary disease which is quite different from that brought about by other forms of inorganic dust.

The trades associated with dangerous dust inhalation have been generally believed to have a higher death rate from tuberculosis than among those not exposed to this factor. This relationship between tuberculosis and dust inhalation forms a problem which is at present far from being answered, as many of the cases of so-called phthisis among dust workers have in all probability been cases of pulmonary fibrosis and not tuberculosis at all. On the other hand, the deaths among these workmen from bronchitis, emphysema, pleurisy, etc., may possibly have been actually true cases of tuberculosis. The problem is an interesting one and more systematic, scientific study of these conditions are necessary before we can arrive at any definite conclusion.

The investigators who have studied this relationship among the coal miners and potters, are almost universally of the opinion that certain types of dust disease may so closely resemble tuberculosis that they may only be distinguished by a careful and prolonged sputum examination. They also express the opinion that the fibrosis resulting from dust inhalations of certain kinds may aid in preventing the tubercle bacillus in gaining a foothold, or may help to retard its growth when it does become established.

The effect of dust particles upon the lungs varies greatly in different cases, and results in the development of a variety of pulmonary changes. The most frequent condition which may develop is chronic bronchitis of varying degrees of severity, changes may be noted in the alveoli and in the lymph channels with a definite formation of fibrous tissue, and enlargement of the bronchial and mediastinal lymph nodes, usually accompanied by a certain degree of emphysema.

Pneumoconiosis must be looked upon as a combination of bronchitis, bronchiectasis, pulmonary fibrosis, pleurisy and emphysema, in which the pathological processes in the lung have been brought about by a definite etiological factor, in the form of dust. In these cases the various processes mentioned may be present in varying degrees and combinations, the symptoms and signs being dependent upon the degree and extent to which each may predominate, and their description would, therefore, serve no useful purpose, as each will be separately considered under their own special heading. The signs in these cases are frequently extremely confusing, as one would expect in a disease made up of such varying pulmonary changes.

The roentgenologic study is invaluable in the accurate estimation of the degree of the pneumoconiosis and the associated pathologic changes in the bronchi and lungs. From the roentgenologic standpoint these cases have been divided into three stages*; the first stage being characterized by an increase in the hilus shadows, a thickening of the usually prominent trunk shadows, and an undue prominence of the fine linear markings. It is probable that many of the cases in this stage have been mistaken for pulmonary tuberculosis. The second stage is characterized by a more or less uniformly arranged mottling throughout the lung structure due to depositions of dust in the lymph structures, cells and fibrous tissue interspaces, with the addition of a certain amount of localized fibrosis, comprising what has usually been regarded as the typical case of pneumoconiosis. The third stage is characterized by the appearance of diffuse fibrosis and all that the term implies, not differing greatly from the fibrosis

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* Pancoast, Miller and Landis: Amer. Jour. Roentgenology, March, 1918, v, No. 3, p. 129 to 138.

that represents the terminal stages of chronic tuberculosis or some other less common cause. It is sometimes difficult to draw the line between the end of the second and the beginning of the third stage. It has been noted that in the third stage the greatest density is in the subapical region, although this is not the region of the most intense mottling in the second stage.

The treatment of pneumoconiosis is purely symptomatic, being directed chiefly toward the relief of the predominant pulmonary change. The one essential for any one of these dust diseases is an absolute avoidance of further exposure to the dust which has been responsible for the development of the process. The best method to secure this is for the patient to give up the offending occupation. Much may be accomplished in the preventing of these diseases by suction apparatuses of various kinds, the use of water in various processes which might give rise to dust, by improvements in ventilation and industrial methods and by the use of respirators. The use of these dust masks for workmen is not very satisfactory, as the men object to the discomfort incident to their use and are, as a rule, careless in their employment of them.

We have included this consideration of these dust inhalation diseases for the express purpose of calling the attention of the physician to a not uncommon cause for many of the diseases of the lungs. It is exceedingly important in studying any patient suffering from pulmonary disease of a persistent or obscure nature to inquire carefully into the nature of the man's occupation. By this word "occupation" is meant not the title of the man's trade but to actually find out just what is the character of the work the man performs. A few examples may illustrate the importance of following out this rule in a careful manner. A man with marked pulmonary fibrosis and chronic inflammation came under my care at one time who gave his occupation as inventor and president of a business corporation. Questioning revealed the fact that he had invented an ore separator and that one of his important duties was to spend considerable time in the ore separators to study whether they were working properly. Again, many men give their occupation as felt-

hatters, when one would obviously think at once of the inhalation of dust, and yet in many of the processes in connection with the manufacture of felt hats the men work constantly in water, where dust would be impossible. There are many processes in connection with the so-called dusty trades in which the individual is no more exposed to dust than would be the average individual, and on the other hand there are many occupations not usually included among the dusty trades, in which the man's work may include the exposure to a very considerable amount of dust.

This fact must be borne in mind in the study of every case of pulmonary disease if our therapeutic measures are to be attended with success.

PULMONARY FIBROSIS.

An excess of fibrous tissue within the lung has been given a variety of names; chronic pneumonia, interstitial pneumonia and cirrhosis of the lung being a few of the terms which have been applied to this disease. The formation of this fibrous tissue may develop from the walls of the alveoli or from the thickening of the subpleural, interalveolar, peribronchial or perivascular connective tissue, these lesions usually being found in association, with one or the other type predominating.

While this process is considered under a separate heading, it must not be taken to represent a definite disease, as it is almost invariably a pulmonary change secondary to some other disease, in many instances being in reality a healing or reparative process. Thus we find it most frequently occurring as a result of pulmonary tuberculosis, especially in the chronic or fibroid forms of that disease. This is such an important and frequent type that it deserves special consideration under the heading of Fibroid Tuberculosis. In the present section we will discuss those forms which are not associated with tuberculosis, but are the result of lobar pneumonia and subacute indurative pneumonia, broncho-pneumonia with collapse, bronchiectasis, the inhalation of irritant substances, pleurisy, syphilis, foreign bodies in the bronchi, from pressure of aneurism, and in association with malignant

disease, mycotic infection 'and less well understood chronic inflammatory processes in the lung.

A number of these etiologic factors have been considered in separate sections of this article, but it is important that the various manifestations of this condition be now considered in more detail, as this is such an important condition, and one which is not so generally well recognized.

There is probably no one condition, if we were to include the tuberculous type, which is more capable of producing in individuals in middle life those pulmonary changes which may be responsible for a lowered efficiency or even an invalidism of moderate degree in later years. It is, therefore, essential that we devote special consideration to the etiological factors, for in the treatment of these other diseases it is important to bear in mind the possibility of the development of this condition, to look for the early indications of its presence and to apply such measures at the earliest possible moment as will aid in the preventing of the development of this process, which is so resistant to treatment when well established.

Before taking up a description of the etiological factors it is necessary to describe briefly the actual pulmonary changes which may be found and in what form the disease manifests itself. The main varieties of the lesion which may be met with are: (1) The massive or lobar form; (2) the insular or broncho-pneumonic form; and (3) the reticular form.

1. The massive type usually affects one lobe, most frequently one of the lower lobes, and is unilateral. The lobe (or rarely, lobes) is usually contracted, firm, nodular, and dense, in some instances it presents a finely granular appearance. Dilatation of the bronchi is not uncommon and the pulmonary tissue in the neighboring regions is usually emphysematous. Pleural adhesions and thickening are commonly present. We have then a process which usually involves one of the lower lobes, the fibrous tissue with its tendency to contraction producing the characteristic changes.

2. The most common form is the broncho-pneumonic form, characterized by patches of fibrosis, which may be located anywhere, but usually are found in the lower lobes. The

lung tissue intervening between the patches is either normal or emphysematous in appearance and frequently traversed with trabeculæ of fibrous tissue. Bronchiectasis is frequently present, usually of the saccular variety.

3. The reticular form is a rare type of fibrosis which is chiefly of interest to the pathologist. The cases which have been described are characterized by peribronchial thickening with a diffuse symmetrical meshwork of fibrous tissue ramifying throughout both lungs. It has been looked upon as due to bronchitis and peribronchitis with an extension of the fibrosis throughout the lungs.

Pulmonary tuberculosis as a factor is considered in a special section. Pneumonia as a cause of fibrosis is by no means a common finding, but it must be recognized that pneumonia may be occasionally followed by a failure of the exudate to resolve, resulting in a progressive fibrous tissue formation and induration. The factor which determines this failure of the pneumonic process to resolve is unknown, although recent studies of the phenomena involved in this process may result in shedding some light on this question.

Bronchopneumonia with scattered patches of collapse of the lung may give rise to this condition, and it is, therefore, essential that pneumonia in childhood, especially those cases following measles, whooping-cough and scarlet fever, should receive careful supervision for some time after all symptoms of the acute disease have disappeared, in order to be sure that there are no unresolved patches of consolidation remaining and that the lung has returned to a normal condition. It is not uncommon to find in children, for a long period of time after an attack of pneumonia, even years in some cases, evidences of a chronic low-grade inflammatory process over the area involved in the pneumonic process. This is characterized by slight impairment, localized râles of varying size and an indefinite quality of the breath sounds, which are not a clear, normal vesicular character. It is barely possible that this state of affairs may eventually result in definite fibrous changes which may produce decided disease in the adult. While this course of events cannot be considered to have been definitely established it would seem advisable to keep

all cases of bronchopneumonia under observation and treatment until the lungs have returned to a normal state.

While bronchiectasis is given as a possible cause of pulmonary fibrosis, the rule is for the fibrous process to be the primary disease, the dilatation of the bronchi occurring secondarily.

Pneumoconiosis may be the direct cause of fibrous tissue formation in the lung, even in those cases which are not associated with tuberculosis, the changes set up in the lungs and bronchi by the small irritating particles of inorganic dust being frequently followed by the developemnt of fibrosis.

The views in regard to the formation of fibrous tissue from lesions of the pleura, the so-called "pleurogenic cirrhosis," are not in complete accord, some investigators believing that it is possible for an indurative process of the lungs to develop directly from disease of the pleura, the fibrous tissue extending from this point directly into the pulmonary tissue. Others believe that for this to occur it is essential that the primary inflammatory process of the pleura must also extend well into the subpleural and adjacent lung tissue. While this question may possess a pathological interest, it is unimportant from the clinical standpoint, the essential fact to be borne in mind being that inflammation of the pleura may be followed by a fibrosis which may extend deeply into the lung tissue, with the subsequent changes incident to fibrosis of the lungs. This change seems to be more frequent in those cases in which the pleura has been definitely infected, causing either a generalized or localized empyema, even when there has been no decided compression of the lung by a massive effusion. The process is more likely to develop in the cases in which the empyema has been of fairly long standing with the formation of considerable pleural exudate.

Inflammatory processes of the lung may eventually result in the formation of fibrous tissue, whether the result of a foreign body in the bronchi, or of some of the more obscure low-grade infections. The healing of syphilitic disease, especially of the gummatous type of the lung, may also result in fibrous tissue formation.

Pressure from an aneurism may not infrequently result in an extensive fibrosis which may invade an entire lung,

through the obstruction to the main bronchi in the region of the aortic tumor. Malignant disease of the lung, pleura or esophagus, or chronic cardiac disease, may at times be accompanied by indurative changes in the lungs.

The symptoms of this disease are dependent upon the predominant changes produced by or accompanying the fibrosis. Thus the patient may present the clinical picture of bronchiectasis, and the degree to which this bronchial dilatation is present governs, as a rule, the character of the symptoms and to a large extent the physical signs. The symptoms most commonly present are cough, expectoration, and dyspnea on exertion, and cannot be considered in any way peculiar to this disease. A moderate degree of fibrosis, and even bronchial dilatation, are not incompatible with a fair degree of general health, although sooner or later an increase in the severity of symptoms may be anticipated with a general lowering of the physical capacity of the patient, elevation of temperature, with eventually symptoms of cardiac and renal failure. The physical signs vary with the location, extent and character of the pulmonary process. There is usually distinct evidence of localized diminution of expansion in the affected area with contraction of the chest and displacement of the mediastinum, heart, diaphragm and abdominal viscera. The displacement of the apex beat is usually one of the first changes which may occur, being toward the affected lung. In right-sided disease the heart may be drawn over to the right side of the chest, resulting in complete dextrocardia. When the disease is on the left side the apex beat in extreme cases may be in the axilla, posterior axillary line or even in the midscapular line. If the contraction of the chest is marked, spinal curvature is almost certain to be present, the convexity of the spinal curve being away from the affected side.

On percussion the resonance is impaired, corresponding to the degree to which the air-bearing tissue has been reduced. The impairment may be obscured or masked by the compensatory emphysema which may be present. Whenever extensive bronchiectasis is present the percussion note may be woodeny or tympanitic. The breath sounds may be broncho-vesicular, bronchial or cavernous, depending on the

lesions present, frequently being of mixed types which may be very confusing. Large, moist bubbling râles may be present over the affected area, and usually evidence of a generalized bronchitis is noted.

These cases may be extremely difficult to differentiate from pulmonary tuberculosis of the fibroid type. The repeated absence of tubercle bacilli from the sputum, the fact that the lesion is unilateral, and its affecting chiefly the base of the lung would be signs suggesting the probability of the disease being non-tuberculous. Occasionally imperfect absorption of a pleural effusion is not followed by a reëxpansion of the lung, under which circumstance the possibility of pulmonary fibrosis being present might arise. The differentiation between thickened pleura and fibrosis should not prove very difficult in the majority of cases, the history of the case and the physical signs should serve to distinguish between these two processes. There are several conditions, such as malignant disease, which may closely resemble fibrosis in many instances and only be differentiated by the clinical course of the disease.

The x-ray may be of considerable value in some of these cases in confirming the physical findings and in uncovering deepseated processes which may be masked by the overlying lung tissue. The important point which frequently may be cleared up or definitely settled by this method of examination is the condition of the apices, as in many of these advanced cases in which the lungs are filled with moist bubbling râles the presence or absence of infiltration of the apices is not always easy of determination. The x-ray may also be of value in determining the etiological factors which may be at the bottom of the process, such as foreign body, pneumoconiosis, malignancy, loculated empyema, etc. It is essential that the stereoscopic plates be interpreted by someone who has had a wide experience in chest diseases, as otherwise the x-ray may only confuse or mislead the clinician.

There is nothing in the way of specific treatment as far as the fibrosis is concerned, and the course to be pursued in these cases will depend on the underlying process involved, the treatment of which will be found under their respective headings.

FIBROID TUBERCULOSIS.

The importance of tuberculosis in those of middle life can hardly be exaggerated, for this disease which is usually encountered in childhood as an invasion of the osseus and glandular systems, and in youth as an acute, progressive disease of the lungs, is usually (although by no means exclusively) met with in those of middle life as a low-grade infection of the lung characterized by the formation of fibrous tissue.

Before considering this disease in its well-developed extensive form, it may be of interest to consider a phase of the tuberculosis problem which is of considerable clinical interest and importance, namely, the presence of slight apical fibrosis. No one who has had considerable experience in the examination of the lungs of large bodies of men, but has been impressed with the frequency with which individuals are encountered with more or less definite signs at one apex, indicative of an increase in density and contraction of the lung. This is a common source of uncertainty in those who apply for a general health examination, either for their own satisfaction or for the obtaining of insurance, and may be a matter of considerable importance in the examination of large industrial groups or candidates for military service. Some clinicians maintain that slight signs at the right apex are to be considered as normal, a view which while it may have some basis in fact, cannot be accepted as correct. The grounds upon which this view is based rest in the fact that the right apex is normally smaller than the left in the region of the clavicle, owing to the fact that the superior vena cava, right innominate vein and subclavian vessels impinge upon it at this point. For this reason the note is not as resonant as on the left under normal conditions. It is only fair to state, however, that the difference in resonance between the two apices is so slight that it is only appreciable to one whose work requires him to be examining lungs constantly and carefully, and anyone whose work is not so specialized would be wiser to consider any difference between resonance of the two apices as an indication of some pathological change. There is another reason for this view in regard to the right

apex, and that is that the right apex lies in much closer proximity to the trachea, resulting normally in a more distinct bronchial character of the breath sounds and a more definite increase in the transmitted voice sounds at this apex, according to many reliable authorities. It must be apparent from the foregoing that an absolute essential for a proper interpretation of the physical signs obtained at the apices, one must be thoroughly familiar with the normal conditions by prolonged repeated studies of this region.

It is perfectly justifiable to assume that when one encounters an individual in which there is distinct impairment at an apex, accompanied by definite broncho-vesicular breathing, in excess of what one would consider as normal if on the right side, and with a distinct increase in vocal resonance, that one is dealing with an infiltration of some kind. The assumption becomes more certain if accompanied by evidences of retraction and diminished expansion or lagging (retarded expansion) in that region.

The interpretation to be placed upon the findings will depend almost entirely upon the previous history and present symptoms of the patient, as we have no other means of accurately determining, in the presence of the signs outlined, whether we are dealing with a recent active lesion, or merely with the minor changes resulting from a previous infection. The fact that the signs are located at the apex strongly suggests that the original factor responsible for their presence is the tubercle bacillus. It may be well to caution, however, that very careful observers have not infrequently called attention to apical lesions which have been apparently due to syphilis, and to non-specific infections.

When the above signs occur in an individual who has had no symptoms for a long period of time suggestive of an active tuberculosis process, who is apparently in perfect health at the present time and shows no symptoms pointing to disease of the chest, no chronic gastric disturbance, loss of weight, elevation of temperature, or increase in pulse rate, one may assume that one is dealing with a healed tuberculous lesion of the lung. The degree and extent of the signs merely indicate the extent of the original lesion.

It is occasionally exceedingly difficult to determine whether the evidence of pathological changes at the apex bear any relation to the present disability of the patient, and unfortunately there is no absolute method of deciding this question at the present time. The symptoms of the patient, the previous history and a careful general study of the patient to exclude other possible causes for his symptoms, is the only available method of arriving at any conclusion as to the apical process in the lung being the responsible factor.

We have described so far the slight manifestations of fibroid tuberculosis of the lung, confined to the apex or apices of the lungs, which may be grouped under these headings: (1) Definite fibroid tuberculosis associated with systemic manifestations of tuberculosis, the involvement of the lung being more or less well defined; (2) definite evidence of fibroid change at the apex or apices, which is, in all probability, the results of previous tuberculous disease which has undergone healing; and (3) slight signs indicating fibroid change, which may be so indefinite as to raise the question as to whether or not they should be considered as normal physical signs when present at the right apex. Many observers look upon this third group of cases as belonging to, or the signs being prdouced by, an old infection with tuberculosis which has never developed to the point where it could be considered as active tuberculosis disease. When one comes to consider extensive fibroid tuberculosis one finds that the manifestations, as far as the physical signs are concerned, are in no way distinctive, being practically identical with those of fibroid disease of the lung which is due to conditions other than tuberculosis. The relationship between fibroid disease and tuberculosis has been described as of three varieties: (1) Pure fibroid disease, which bears no relation to tuberculosis in any way: (2) fibroid disease, primarily of a nontuberculous character, which has had engrafted upon it or become complicated by tuberculosis; and (3) fibroid changes which are the direct result of tuberculosis, and which must be considered as merely a pathological and clinical form of that disease. It is this third type, by far the most common, which we will now proceed to consider. The second form is purely of pathological and scientific interest, as we have

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no means of distinguishing it during life from the third type. The first type mentioned has been considered under the title of Fibroid Disease.

The pathological process which forms the basis of this disease is dependent upon fibroid transformation of miliary tubercles which do not go on to caseation and softening. The characteristic processes may be found in the form of isolated granulations; groups of these granulations; or in irregular, dense fibrous areas, around the margins of which may be found isolated or conglomerate granulations. There is no evidence of softening in the tuberculous masses, which may be almost cartilaginous in density and are usually very deeply pigmented. The process usually involves the peribronchial tissue and the interlobar connective tissue, in the majority of cases showing none of the striking alveolar inflammatory processes so common in other forms of tuberculosis. It is not uncommon to find a certain amount of over-distention of the alveoli in the surrounding or neighboring lung tissue, and the surface of the lung may usually be seen to have a puckered or dimpled appearance due to the localized retraction of the fibrous bands, which is exaggerated by the over-distention of the intervening alveolar tissue. Cavities, when present, are usually small, dry, and with sharply defined walls, surrounded by very dense fibrous tissue. Their presence usually indicates that the fibroid tuberculosis has developed from a more acute fibrocaseous type of the disease, in which cavity formation so frequently occurs. It is evident that the morbid process characteristic of this form of tuberculosis presents quite a different picture from that found in other forms.

The factor that is responsible for the determination of type of the tuberculous process is unknown. We have no means of knowing why a tuberculous infection in one individual gives rise to an acute, rapidly disseminating, caseating process and why in another it should lead to a chronic, indolent, fibrous-tissue forming disease. We do know, however, that this chronic type is found more frequently in men and is much more common in older individuals, being relatively rare in the young. We have no way of telling at the present time whether the difference is due to variations in

the virulence of the invading organisms, to the location of the primary infection, or to the differences in the resistance of the individual, the nature of which is not known.

The symptoms of this disease are in no way peculiar or striking, cough accompanied by varying amount of expectoration, more or less loss of weight and strength, and occasional slight rises in temperature being usually the only ones present. The patients suffering from this disease are usually considered as cases of bronchitis, although some cases resemble very closely emphysema or even asthma. Hemoptysis may occasionally occur, and may be the first and only symptom to suggest that the patient is suffering from tuberculosis. The temperature is usually subnormal in the morning and may be normal in the afternoon or only slightly above normal, although these cases are liable to spells during which the temperature may become distinctly elevated.

The expectoration is usually not excessive and possesses no characteristic features other than the presence of tubercle bacilli, which are usually few in number and may be only discovered after repeated examination of the sputum.

The physical signs are frequently vague and in no way striking, but on the other hand may in some cases become very marked, out of all proportion to the physical well-being of the patient. When the disease is of only moderate extent we may find retraction at one or the other apex, with diminished expansion over the upper part of the chest on the affected side. The degree of dullness varies with the density of the process, in some cases being very marked and in others being merely an impairment of resonance. The breath sounds correspond, as a rule, with the percussion findings, varying between marked broncho-vesicular breathing and very slight broncho-vesicular breathing. The râles are usually scattered over the chest and are usually fairly large, although occasionally small areas may be discovered, over which persistent, fixed, fine moist râles may be heard, frequently being only brought out by a deep breath following a cough. When cavity is present it may usually be recognized by its characteristic signs, and will usually be found to be dry.

In certain of the cases of this disease the signs are obscured by the presence of the over-distended or emphyse-

matous condition of the pulmonary tissue lying between the areas of fibrosis. This emphysematous condition may over-shadow the impairment on percussion, giving one a hyper-resonant note. To the experienced ear, however, the note which is detected in these cases, while having a hyperreso-nant quality, differs from the full hyperresonance of the purely emphysematous chest, the note being shorter and higher in pitch. At the same time the over-distended lung may obscure the bronchial character of the breath sounds, and all one may hear is the soft, prolonged expiration of the over-distended lung.

When the disease occurs in individuals who are well-advanced in years the percussion findings may be extremely misleading, it being very difficult in some of these cases to determine whether there is impairment in certain areas on percussion or not, as the note over the entire chest is so often lacking in true, clear-cut resonance. Many of these cases also give very indefinite findings on auscultation, so that in certain elderly individuals one may only make a definite diag-nosis upon the presence of tubercle bacilli in the sputum.

The condition may so closely resemble emphysema or asthmatic bronchitis that they may only be recognized by a very careful examination. It is very possible that many of the cases that are considered as being emphysema or asthmatic bronchitis, especially when occurring in individu-als who are well on in years, are not infrequently cases of fibroid tuberculosis, a point to be kept in mind in the study of these cases.

This form of tuberculosis is not uncommon in those individ-uals whose occupation has exposed them to the deleterious effects of irritating, inorganic dust particles. It is not un-common among grinders, polishers, stone-cutters, and so-forth, although one must acknowledge that it is impossible to draw any clear-cut dividing line between the pulmonary lesions in these cases resulting from the dust itself, and those produced by the tuberculous disease. The fact remains, how-ever, that when these pneumoconiosis cases do develop tu-berculosis of the lungs, the disease very frequently occurs in this fibroid form.

There is another form of fibroid tuberculosis which is not infrequently encountered, known as *fibroid phthisis,* which is in striking contrast to the one just described. In this type the fibrosis is very massive, at times involving almost one entire lung, usually accompanied by cavity formation, thickening of the pleura and marked deformity of the chest. This usually follows a well-marked attack of pulmonary tuberculosis of the fibro-caseous type, with extensive pulmonary involvement. As the result of treatment or for some undetermined reason, the process may become fairly well-arrested, with the development of extensive, even massive, fibrous tissue formation. These cases are by no means uncommonly encountered and may even be detected in individuals who are active and are capable of performing the duties of an active life. The majority of them, however, while fairly comfortable, are only able to retain this state of relative well-being by exercising the greatest care in their mode of living.

In this type of case we usually find the cough and expectoration are very prominent symptoms, dyspnea is usually marked, with more or less loss of weight and strength, and a moderate degree of temperature. On examination we find signs of involvement which extend throughout a large part or the whole of one lung, and with usually some evidence of involvement at the top of the other side. On the more seriously affected side there is usually very marked depression above and below the clavicle, decided retraction of the whole chest and practically an absence of respiratory movement. The upper part of the chest usually reveals well-marked signs of cavity, frequently over an extensive area. Below this area of cavitation is usually a zone over which there is marked dullness, bronchial or tubular breath sounds, and large metallic râles. Over the lower portion of the lung may usually be found dullness, indefinite breath sounds, and numerous fine moist râles.

There are certain writers who question the accuracy of considering these cases under the title of fibroid tuberculosis. They are so different from the true fibroid tuberculosis in their pathology and clinical manifestations that some distinction should be drawn between these two forms. I have

included this rather brief description of this type of case at this point merely for the purpose of contrasting them with the typical fibroid tuberculosis, although they are both examples of tuberculosis associated with the formation of fibrous tissue.

SUMMARY.

From the standpoint of the diseases of middle life, just what is the significance of fibroid tuberculosis, as far as being a factor in bringing about changes which might interfere with the well-being of individuals in later life or even shorten life? From the standpoint of life itself these cases of fibroid tuberculosis not infrequently must be considered as serious. The disease may become so extensive that death may result or the chronic fibroid type of tuberculosis may less frequently develop into a more rapidly extending ulcerative form of the disease, with all the manifestations of active tuberculosis. While this transformation from one type to another is relatively uncommon in individuals in middle life, it is by no means a rarity, and the possibility of its occurrence should be constantly borne in mind and guarded against. Every clinician who has the opportunity of seeing many cases of tuberculosis will be able to recall cases of active pulmonary tuberculosis in individuals who are even advanced in years (seventy to eighty years), many of which have presented evidence of a chronic fibroid tuberculous process in the lungs for many years previously. While the disease may endanger life by the development of an active process, its effect upon the individual is usually of a different nature.

The individual who has chronic fibroid tuberculosis more frequently suffers from the disease in being less robust and vigorous than normal, more poorly nourished and more liable to frequent, severe attacks of bronchitis. The process is not uncommonly responsible for the cases of semi-invalidism so frequently met with in individuals who have reached the later years of middle life. The fibroid tuberculosis is not infrequently the actual pathological process which is responsible for many cases of so-called "chronic bronchitis," "emphysema," and "asthma," occurring in those of middle age.

It should be constantly borne in mind in the study of any individual presenting evidence of chronic pulmonary disease, that a patient, prolonged, careful study of the sputum in many cases with obscure physical signs will not infrequently reveal the fact that the tubercle bacillus is the etiological factor.

TREATMENT.

The treatment of the case of chronic fibroid tuberculosis will usually call for the exercise of considerable clinical judgment, to determine how energetically the treatment must be carried out. Many of these cases are capable of performing a considerable amount of work provided it is of a nature that does not call for a great amount of physical effort or strain, under favorable general conditions. The only treatment which these cases will require is advice as to the amount of rest and fresh air they should obtain, directions as to their diet, and so forth, the only medication required being directed toward improving their digestion or toward correcting some of their more annoying symptoms.

When the disease becomes marked, however, it may not infrequently be necessary to institute a régime which is more radical and energetic. Absolute rest in bed may become imperative if one is to prolong the patient's life or to secure an improvement in general health and strength. It must also be borne in mind that the marked process not infrequently exercises a very unfavorable influence upon the circulatory organs, and the rest in bed may become necessary to afford relief to the heart. Care must be exercised in securing fresh air for these cases, as most of them will object to an unlimited supply on account of the chilling which usually results. If one is careful to see that the head and body are properly protected from the cold air, no difficulty should be encountered in having sufficient fresh air. The most serious obstacle which the physician has to contend with in most of these cases is their disinclination to take sufficient nourishment. Many of these individuals have been accustomed to eating sparingly for a number of years and considerable patience, perseverance and ingenuity will be required to increase the daily amount of nourishment which

they will take. Small quantities of easily digested food at frequent intervals will usually answer the purpose better than large quantities three times a day. The food should be as well prepared and as attractively served as possible, and in as great a variety as may be secured. There is nothing so depressing to the appetite as monotony. This is one of the chief objections to the milk and egg diet, which is undoubtedly one of the most valuable in conditions of this kind. If the patient resists taking the milk and eggs in the raw state after a careful trial, considerable nourishment may be provided in the form of cream soups, purées, milk-shakes, and so forth. The milk and egg diet as employed in other forms of pulmonary tuberculosis is such a valuable means of improving the general health of the patient that it should never be given up until one has employed every means of having the patient become reconciled to it.

The medication which will be found necessary will usually consist of those aids to appetite and digestion commonly employed. There are very few individuals who, when forced to take an amount of nourishment in excess of their desires, are not benefited by some simple digestive preparation, the physician being guided in the drugs to be employed by the symptoms and signs which may be present. The majority of these cases will require very little if any treatment for the cough and expectoration. When these symptoms do become severe the line of treatment described under bronchitis may be employed. It is a serious mistake to employ expectorants routinely in these cases, as nothing will so interfere with the proper digestion of food as most of the drugs of this type. When the patient is expectorating freely and easily without very much effort there is no necessity for employing any expectorants unless the expectoration should become excessive in amount or exceedingly purulent. Under these circumstances the drugs like terpin hydrate or creosote will usually be of considerable help. The terpin hydrate should be taken in the form of the elixir or in capsule, and the creosote in hot water or possibly in some combination like calcreose.

It must be borne in mind that in many of these cases the disease is of long standing and resistant to treatment. One

will not secure any very decided improvement or relief of symptoms in a short period of time, and, therefore, must not be tempted to make frequent changes in treatment because the response is not decided or striking. Having decided upon the line which is indicated in the individual case, one should persevere until convinced that another line should be followed, as far as one is able without antagonizing the prejudices of the patient. Perseverance, patience and good judgment in the treatment of these cases will frequently be rewarded by a return to health and well-being, even in some cases which are apparently hopeless. The results to be obtained will, to a large extent, depend upon the amount of infiltration in the lungs and the condition of the other organs in the body. The cases with extensive lesions may never regain their working capacity or their former strength and vigor, and yet with care and attention may be brought to a state of fair well-being, able to play a minor part in the workaday life. If the involvement is not very great most of these cases may be returned to a state of health which will permit them to perform considerable work provided they guard their health, avoiding excesses of all kinds. Only a very few will be able to live the abnormal life of the average individual—careless alike of the overdevotion to work and to pleasure, with irregular hours for eating, lack of sufficient rest and the overindulgence of every appetite.

SYPHILIS OF THE LUNGS.

The study of this disease in the adult necessitates confining one's attention to the manifestations of the acquired form, ignoring the pneumonic type seen in new-born infants. The disease has usually been looked upon as rare, although a number of competent observers are of the opinion, based on what appears to be reliable information, that the disease is clinically more common than the figures based on autopsy studies would indicate. It is not certain whether this is due to the fact that certain pulmonary manifestations are not recognizable after death as being due to syphilis, or whether syphilis may produce disease of the lungs from which the individual may recover without leaving any characteristic

pathological changes. Regardless of the frequency of the disease, the possibility of syphilis being the cause of chronic disease of the lungs in cases in which no definite etiological factor can be established, should be constantly kept in mind, especially as the recognition of the *Spirocheta pallida* as the factor in obscure pulmonary disease establishes at once a very definite line of therapeutics which promises rapid and complete recovery in many instances.

The pathological manifestations of this disease in the lungs may be in the form of gummata, fibroid induration, consolidation and catarrh. The gummata usually occur in the region of the hilus and in the lower lobes but may be found in any portion of the lung, they are usually numerous and vary greatly in size. Caseation may occasionally occur or they may become walled off with fibrous tissue. When healing takes place nothing but scar tissue may remain which is indistinguishable from scar tissue resulting from any other form of disease.

A more frequent manifestation is fibroid induration which usually has its starting point in the region of the hilus, but may develop from the pleura or interlobar septa. The extensive cellular infiltration and overgrowth of the connective tissue in the interlobar septa and proliferation and degeneration of the alveolar eptihelium is followed by the formation of dense fibrous tissue, which may present the clinical picture of pulmonary fibrosis or bronchiectasis.

There is another form of the disease in which the focal manifestation consists of an area of consolidation and catarrh which may occur at the root of the lung or at one apex. The view has been held that syphilis never affects the apices of the lungs but several recent observations seem to indicate that this disease may be occasionally responsible for evidence of disease located in this region.

The variety of the pathological processes in syphilis of the lungs would suggest that there is nothing typical in the symptoms, which are dependent upon the location, extent and character of the lesions. It might be said that in any chronic disease of the lungs, whether in the nature of a bronchitis, bronchiectasis, pulmonary fibrosis, tumor, or even apical infiltration, in which tuberculosis can be excluded or

not absolutely demonstrated, or in which no other etiological factor can be determined with any degree of positiveness, the possibility of syphilis being responsible for the process should be constantly borne in mind.

While the x-ray may be of value in confirming the physical findings as to location, extent and character of the lesion or even in adding to our knowledge of the pulmonary process, there are no findings which can be brought out by this method of study upon which an absolute diagnosis of syphilis can be based, although certain features may be detected which might suggest the possibility of luetic disease being present.

The Wassermann test is the most valuable means we possess in confirming the diagnosis of pulmonary syphilis. Yet even here a word of caution might not be out of place, as it must be borne in mind that in an individual suffering from pulmonary disease the presence of a positive Wassermann test does not indicate that the pulmonary process is of necessity the result of syphilis, as the syphilitic patient may be suffering from pulmonary tuberculosis or any other form of pulmonary disease. The positive Wassermann test does, however, strongly suggest the probability of the disease of the lung being of a syphilitic nature when other diseases can be excluded, and in any case it suggests a method of specific treatment which may be followed out with benefit to the patient.

The disease for which pulmonary syphilis is most frequently mistaken is tuberculosis, and in fact the symptoms and frequently the signs may at times be practically identical. If the signs are confined to the root of the lung or the base, one may practically rule out tuberculosis. Repeated negative sputum examinations for tubercle bacilli or the other organisms which produce similar lesions, in the patient with suggestive evidence of syphilis in some part of the body, and the positive Wassermann test, would warrant one in making the diagnosis of syphilis of the lung. The diagnosis would be confirmed by the results of antisyphilitic treatment, although it must be remembered that in extensive fibrosis resulting from syphilis one would not look for any marked change from any line of treatment.

MALIGNANT DISEASE OF THE LUNGS, PLEURA, AND MEDIASTINUM.

Malignant tumors of the chest are by no means a rare occurrence, and while they are usually secondary to a growth in some other portion of the body they may rarely appear as primary tumors in this region. While carcinomata of the chest may occur earlier in life, they are more frequent between forty and sixty years of age. The sarcomata, on the other hand, not infrequently occur earlier in life, usually arising from the mediastinum and are more frequently primary in this location. It is a mistake to consider malignant disease of the chest as an unusual condition, and the possibility of malignancy being the factor responsible for the signs and symptoms should always be borne in mind by the clinician, in the study of obscure disease of the chest.

The determination of the primary focus of the tumor, whether the pulmonary tumor should be considered as a primary or secondary growth, and whether it should be viewed as a tumor of the lung, pleura or mediastinum, possesses considerable interest from the pathological standpoint, but from the clinical aspect these factors are not of so much moment, as the true nature of the disease is seldom recognized until it has so spread by extension that it is impossible to even venture an opinion as to its primary seat. For example, a tumor mass which has originated in the lung will frequently so involve the lymph glands that the signs and symptoms will suggest a mediastinal tumor; or it may lead to the development of a pleural effusion, either by pressure or by direct involvement of that membrane, leading the clinician to the belief that he is dealing with a primary growth of the pleura. The case may occasionally come under observation while the involvement is still confined to a restricted area at the point of origin, before extension has taken place, when the physical signs and symptoms will naturally vary with the location of the growth.

For the sake of simplicity the clinical features of the growth in these three locations will be described separately, with the understanding that they more frequently occur in combination.

Tumors of the Lung. The growth in this location may occur in the form of a diffuse, disseminated distribution of the newly formed tissues throughout the lung, or as discrete tumor masses of varying size, single or multiple, which while more frequently located near the hilus, may be located in the periphery of the lung. Both lungs may be involved but it is more common for the process to be confined to one lung, especially in the primary growths, or at least to be more marked in one lung. Rarely the tumor mass may originate within a bronchus, leading to signs and symptoms of obstruction suggesting the presence of a foreign body.

The symptoms of malignant disease of the lung are in no way characteristic, there being usually nothing about them which would suggest the likelihood of the process being of a malignant character, at least during the early stages of the disease. It has been frequently noted that the dyspnea in these cases is extreme, being out of all proportion to the amount of pulmonary involvement, a fact which might suggest this probability in certain obscure cases in which dyspnea is a feature. Cough is a fairly constant symptom and may frequently persist for a long period of time without being accompanied by expectoration. When the growth is so situated as to encroach upon or make pressure upon a large bronchus the cough may be characterized by its brassy quality, accompanied by stridulous breathing. At first the expectoration is scanty and mucoid in character, and may or may not be blood-streaked, later becoming mucopurulent. During the early stages of the disease the health and strength of the patient commonly remain unaffected for a considerable time, although they are invariably diminished when the growth has assumed any very decided proportions. Fever is usually present, even fairly early in the disease, being of an irregular type, frequently disturbing the patient less than one is accustomed to note in fevers of equal height when due to other processes. While pain is not uncommon it is rarely a striking feature of the disease, and when present is usually felt in the axillary, scapular, acromial, or sternal regions. The patient frequently complains of a vague sense of fullness, or oppression in the chest which interferes with or restricts respiratory movement.

The physical signs are not infrequently very puzzling, being of an irregular, atypical character and varying with the location, size, and nature of the growth. In some cases the signs are exceedingly scanty, so much so that occasionally the diminished expansion on the affected side may be the only striking feature, or even the only marked sign present, for a considerable period of time. When the process is of a diffuse, disseminated type one will observe irregularly distributed patches of impairment or dullness on percussion associated with fine moist râles, absent breath sounds or very slight broncho-vesicular breathing, these signs being as a rule not confined to any one lobe or area of the lung. In the presence of discrete tumor masses one will note well-defined circumscribed areas of dullness, over which one may note a suppression or complete absence of breath sounds, or one may hear a perfectly normal vesicular breathing. This striking contrast between the dullness and the absence of change in the breath sounds suggests that the tumor mass is deeply seated. The signs vary somewhat between those tumors situated in the periphery and those near the hilus; in the latter one may detect distinct bronchial breathing or a peculiar bronchial murmur due to a partial occlusion of a bronchus. In tumors situated in this latter location one more commonly finds associated the signs and symptoms of a mediastinal growth to be described under the next heading.

Tumors of the Mediastinum. The symptoms of this condition are very similar to those described in the foregoing section, although as a rule the dyspnea, hard, dry cough and sense of oppression are more marked in the cases with mediastinal tumors. Owing to the location of these mediastinal growths it is more usual to find symptoms due to pressure by the tumor mass. Thus one is more likely to find stridulous breathing, vocal cord paralysis, dysphagia, dilatation of the superficial veins of the chest, pain and brawniness or edema of the chest wall, breast or arm of the patient. When they are located in the region of the aorta the signs may be extremely suggestive of the presence of an aneurism, even tracheal tug, inequalities of the pupils and localized pulsation of the chest wall may be present. When the tumor becomes

very large it may even protrude above the sternum, when it may be easily palpated in the suprasternal notch.

Tumors of the Pleura. Malignant disease in this region is usually secondary to a tumor in the mediastinum, or the lung, but may occasionally appear as a primary growth in the form of a carcinoma (occasionally called "endothelioma"), or very rarely in that of a sarcoma. When occurring in this region the growth is usually accompanied by a serous effusion, which in the early stages possesses no characteristic features to suggest the nature of the process responsible for its presence, and, therefore, its true character may remain unsuspected for a considerable period of time. There are several points in regard to pleural effusions which should at least suggest to the clinician that malignant disease of the pleura is responsible for its presence, namely: When repeated aspiration is followed by a reaccumulation of the fluid; when the effusion is markedly hemorrhagic in character; when weakness, loss of weight or elevation of temperature are in excess of what one is accustomed to note in serous effusions of other origin; when restriction of motion of the chest wall, dullness, absence of breath sounds, and dyspnea are not definitely relieved by aspiration of the effusion; when a rough, grating sense of resistance is encountered on insertion of the aspirating needle, especially when it requires a deep insertion of the needle before the fluid is reached; when the examination of the chest clinically and by means of the x-ray immediately following the removal of the fluid shows signs indicative of marked thickening of the pleura, or other evidence of malignant disease.

It is a mistake to insist too strongly upon the presence of cachexia before being willing to make a diagnosis of malignant disease of the chest; as cases of this kind are not uncommon in which the anemia and loss of weight and strength do not appear until the process has become quite advanced. Secondary involvement of the superficial lymph nodes may be of value in the diagnosis, although not a very constant feature. The development of tumor nodules in the track of the needle used in previous aspirations may rarely take place, although care must be taken to avoid confusing these nodules with those which occasionally develop in tuber-

culous effusions under similar conditions; excision and microscopic examination of the nodules may be necessary to differentiate between these two processes.

Considerable importance has been at times attributed to the cytological study of the serous effusion in differentiating between those due to a malignant process and those of other origin. The preponderance of cells of an endothelial type, especially when arranged in plaques or sheets, has been looked upon as favoring the diagnosis of malignant disease of the pleura, although they may be present in transudates of purely mechanical origin. The finding of bloody fluid is also very suggestive of a malignant process, but it is by no means pathognomonic, as effusions of this kind have been not infrequently reported in processes of non-malignant origin.

No great difficulty is attached to the diagnosis of malignant disease of the chest in those cases in which it develops during the course of a recognized process in some other portion of the body, or following the removal of some growth in which one has suspected malignant changes, as for example, a tumor of the breast. Under these conditions it is frequently recognized fairly easily because one has reason to suspect its presence. When, however, the malignant process develops as a primary lesion within the chest, or as is not uncommon, it develops secondary to some undetected or even unsuspected growth at some distant point, the true nature of the disease is not uncommonly unrecognized until well advanced, or even not until revealed by a post mortem examination.

The clinician should keep constantly in mind the possibility of malignant disease in every obscure disease of the chest, especially in those in which signs pointing to a definite infiltration of the lung in which repeated negative sputum examinations have been made in a patient with a negative Wassermann test. Where the indications point to a mediastinal growth or where a pleural effusion repeatedly develvelops after frequent aspirations, especially when signs of marked pleural thickening are present, one should always suspect the presence of a malignant process. While the age of the individual is an important point in the diagnosis of this condition, as it is much more common in those of middle

life, it must be remembered that it by no means occurs exclusively during this life period and may be found in young adults or even in quite young children.

In the case presenting signs of definite disease of the chest, in which it is possible to exclude tuberculosis and syphilis, it may be not infrequently possible to arrive at a correct diagnosis by a careful consideration of the history and a correlation of the physical signs and symptoms, the roentgenologic study of the case frequently being of the greatest value in confirming the clinical diagnosis.

The treatment of malignant disease of the chest is at present merely one of amelioration of the pain and distress, as the various methods of treatment employed at the present time, such as x-ray, radium and surgical interference, are practically valueless in these cases, especially as they, as a rule, are not recognized until well developed and frequently are secondary to malignant disease of some other organ.

CHRONIC INFLAMMATORY DISEASE AND ABSCESS OF THE LUNG.

The lungs are subject to a number of chronic infections, most of which are of very rare occurrence, the signs and symptoms of which resemble each other so closely that it would seem advisable to consider them as a single group. Even pulmonary abscess may occur in which the symptoms and physical signs may be identical with those present in these chronic infections, although in many instances the findings more closely resemble those described under bronchiectasis.

The chronic inflammatory diseases of the lungs may be due to a great variety of causes, and while the physical signs and symptoms are very much the same, a careful examination of the sputum will serve to distinguish between them. Actinomycosis, streptothricosis, aspergillosis, spirochetosis and blastomycosis of the lungs, are a few of the more important of these rather rare infections. A number of cases have been described in which the inflammatory process of the lung is the result of an infection with a low-grade, non-virulent strain of staphylococcus, streptococcus, or similar organism.

The symptoms are usually those of chronic bronchitis, but when one comes to examine the chest one finds that there are zones, usually in the lower lobes, over which one may note slight dullness or impairment of resonance on percussion, localized râles which are usually of a fine moist type, slight increase in the voice sounds, combined with indefinite or suppressed breath sounds, or more rarely slight broncho-vesicular breathing. Frequent examinations reveal the fact that these findings are constant or may even show a tendency to become more extensive. While the signs are very much more common over the lower portion of the chest, especially posteriorly, they may be found at any point in the lung, although only extremely rarely at the apex.

The physical signs as given are by no means characteristic and merely indicate the presence of a chronic inflammatory process of the lung. It must also be borne in mind that these same signs may be the only indication of the presence of a pulmonary abscess, foreign body in a bronchus, or a loculated empyema, especially of the interlobar type. When one finds evidence of these chronic inflammations one should at once direct one's attention toward determining the factor responsible for its presence, by careful and repeated physical examination, roentgenological studies, and careful examination of the sputum.

There are also several forms of infection of the lungs due to animal parasites, as, for example, echinococcus disease and pulmonary distomiasis, both of which are extremely rare in this country. Echinococcus disease of the lungs occurs in the form of globular cysts, which may be single or multiple, giving rise to no characteristic symptoms. The signs suggest those of a pleural effusion, without being of necessity at the base, and the area of dullness is globular in shape. This disease is not uncommon in Australia and South America, but is very rare in this country, being occasionally encountered in foreigners.

The parasitic hemoptysis due to the lung-fluke (*Distoma pulmonale*) is endemic in China and Japan and has been reported in Korea and the Philippine Islands, the few cases reported in this country having been imported.

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Bronchial Asthma, Seasonal Hay Fever, and Fibrinous Bronchitis

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Bronchial Asthma, Seasonal Hay Fever, and Fibrinous Bronchitis.

UNTIL very recently the word asthma has been used more or less synonymously with dyspnea, probably because the Greek origin of the word asthma ($\overset{\text{\'}}{\alpha}\sigma\theta\mu\alpha$) meant panting. When the panting respiration or dyspnea was dependent upon the heart, kidneys, stomach, thymus, etc., the condition was called, respectively: cardiac, renal, peptic, thymic, etc., asthma. In fact angina pectoris has been called Heberden's asthma; spasm of the glottis, Kopp's asthma; laryngismus stridulus, Millar's asthma; anthracosis, miner's asthma, etc. We now recognize, however, that the above conditions are entities and that they should no longer be considered kinds or types of asthma; these conditions are now called dyspnea and are symptoms of various diseases. A careful history and physical examination will usually determine these causes of dyspnea already referred to and other causes as well.

At the present time it seems advisable to discard the word asthma and to use the term bronchial asthma as an entity. Bronchial asthma should be considered as an idiopathic disease, or rather should be applied to that form of dyspnea for which there is no evident cause that can be found by physical examination. For convenience we now recognize two kinds of bronchial asthma; in one type there are typical attacks due to bronchial spasm and this is called true or typical bronchial asthma, in the other kind there is little bronchial spasm but much bronchial secretion due to bronchial infection. The following paragraphs will identify the two kinds or types of bronchial asthma as we now consider the condition.

TYPES OF ASTHMA.

Typical Bronchial Asthma. An attack or paroxysm of typical or true bronchial asthma consists of the following cycle of events. Some type of foreign protein, acting either centrally or peripherally as an irritant on the nerves that inner-

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vate the smooth muscular tissue lining the bronchi, causes a spasm or constriction of the bronchial musculature. The muscles of inspiration are equal to the task of drawing air through the constricted bronchi into the air cells of the lungs, but the elasticity of the lungs, together with the muscles of expiration are not sufficient to expel the inspired air in the normal time, so that expiration becomes prolonged and is finally interrupted by an inspiration before the normal amount of air has left the lungs. Consequently, as the attack progresses the lungs become overdistended with residual air, and sooner or later this overfilling of the lungs with air causes labored inspiration, although expiration remains more prolonged and more difficult than inspiration. The attack is now at its maximum and it may continue for only a few minutes or for a few hours. At the height of the attack the patient may develop a dry cough which, in a short time, may become productive in raising a more or less characteristic type of sputum. This sputum is thin, clear, slightly tenacious, and in it are suspended small white tapioca-like masses of mucus called Laennec's pearls. Usually there are quantities of eosinophiles present in the sputum, but they are of little diagnostic significance since they may be present in any sputum, nasal secretion, or inflammatory exudate. Charcot-Leyden crystals, Curschman's spirals, and bronchial casts are not found frequently enough in such sputum to be of diagnostic importance. The attack of asthma begins to subside when sputum is raised. There is no fever and only a slight elevation of the pulse rate accompanying the attack. After the attack has subsided, the patient may be more or less fatigued but is otherwise normal and free from all symptoms until another attack is suddenly precipitated hours, days, or months later, depending upon when some foreign protein is again encountered.

On physical examination, during an attack of typical or true bronchial asthma, inspection verifies what has been already described, and in addition there may be some cyanosis. Percussion of the lungs during the height of the attack reveals a high-pitched resonance. On auscultation expiration is prolonged and feeble, and inspiration is wheezing and accompanied by dry râles; after expectoration has developed there may be moist râles. Fluoroscopy of the chest at the height of

the attack reveals a motionless diaphragm which seems to be fixed in a depressed position, and the lungs expand very slightly on inspiration. An analysis of the patient's alveolar air shows a low carbon-dioxide content, although the blood at the same time shows a normal carbon-dioxide content. After the attack has subsided fluoroscopy of the chest and analysis of the alveolar air show normal findings and the patient's lung capacity is normal. An examination of the blood may reveal an eosinophilia, but this is of little diagnostic importance.

Pathology so far has not advanced our knowledge of this condition, but animal experimentation, however, has enlightened the subject tremendously. Brodie and Dixon[1] have shown that the vagus is the only motor nerve to the bronchial muscles and that in this nerve run two sets of fibers, the constrictor and the dilator. Examination of the sympathetic gave negative results so far as the bronchial muscles were concerned. They found that stimulation of the constrictor fibers of the vagus could be excited by various irritants of the nerve itself or of the respiratory mucous membrane and a typical attack of spasmodic asthma would result: prolonged expiration, distended lungs, dry râles, absence of excessive secretion in the bronchi, no engorgement of the lungs. Auer and Lewis[2] produced a stenosis of the small bronchi which was caused by spasm of the muscle fibers encircling the tubes. Sewall[3] has shown that guinea pigs, especially after previous sensitization, may react to intranasal instillation of horse serum by the development of typical attacks of bronchial asthma such as have been described above. Therefore by putting these findings together, protein applied in the upper respiratory tract of a sensitized animal (Sewall) irritates the constrictor fibers of the vagus (Brodie and Dixon), producing a stenosis of the small bronchi by causing a spasm of their circular muscles (Auer and Lewis), the mechanism of a typical attack of true bronchial asthma is explained.

In the above explanation the only term used that has not been defined is the word sensitized and a few lines will suffice to understand this word. Magendie[4] in 1839 and Richet[5] in 1902 found that the first dose of a protein given to an animal, was followed by a condition of markedly greater susceptibility

to that protein. This phenomenon is called anaphylaxis; the animal is sensitized by the first dose of protein and is shocked by a properly spaced second dose of that protein. The anaphylactic shock due to the meeting of a specific antigen (the second dose of protein) with its antibody (produced by the first dose) and the resulting reaction gives rise to a toxic product which causes the characteristic symptoms. Anaphylaxis therefore consists simply in the cellular reaction due to the fixation of antigen by cellular antibody. In true bronchial asthma we now know that the patient is previously sensitized to some protein but we do not know why, and furthermore we do not know whether it is the whole protein itself, or the toxic product which is produced when the protein meets its antibody, or a toxic split product of the protein (Vaughan),[6] that irritates the nerves innervating the bronchi. Further discussion on this point at present would be endless and futile, but it is certain that the causative agent in the production of an attack of true bronchial asthma concerns a protein.

Atypical Bronchial Asthma or Asthmatic Bronchitis. There is another type of attack commonly met with in patients. who, in the past, have been considered as bronchial asthmatics but who have not, according to our present knowledge, true spasmodic attacks of bronchial asthma, as previously described. Careful observation and study brings out marked differences between this type of attack, which is about to be described, and the true bronchial asthmatic attack, already described. In the past these two distinct types of attack have not been separated and consequently confusion has resulted. Even at present one must not be too dogmatic and entirely divorce this type of so-called bronchial asthma from the true type already mentioned. Nevertheless, the term asthmatic bronchitis would best describe this type of case. In other words the type of attack, already described, must be called true or typical bronchial asthma and the type of attack, about to be described, should be called atypical bronchial asthma or, possibly better still, asthmatic bronchitis.

This atypical attack of bronchial asthma is usually associated with respiratory infections such as colds and bronchitis, chronic bronchitis, catarrhal conditions of the nose and throat, and occasionally with infections of the teeth, tonsils, and sin-

uses, and rarely with infections located in any part of the body. The primary cause is bacterial infection. Proteins are not the cause of this type of asthma, with the exception that occasionally bacterial protein may be the cause, and therefore in only these occasional cases may this type of asthma be anaphylactic. Patients with this type of asthma usually develop their attacks in one of two usual ways. The most common manner is as follows. The patient has been subject to bronchitis for a period of months or even years. During this time the symptoms of bronchitis have progressed and have become more and more severe. At first possibly there may be only a slight unproductive cough which may have followed a neglected cold; later the cough is more annoying and may become productive of expectoration. There may or may not be slight fever and the patient, since physical signs are practically negative, may be suspected of having tuberculosis. After a time there is some difficulty in breathing, especially on exertion. Later still, respiration becomes wheezy, and dry rhonchi are heard on auscultation. If these symptoms progress no further the condition is called bronchitis. If, however, the patient develops attacks of dyspnea (it is inspiratory in type) and suffocation, with or without exertion, the condition is called bronchial asthma. In reality the condition is a severe type of bronchitis and does not closely simulate typical bronchial asthma; the condition is more correctly asthmatic bronchitis.

The manner, next most common to the above, in which patients develop this kind of asthma is as follows. As in the above case, the patient becomes subject to chronic bronchitis, and although he is more or less troubled with it during the time he is awake, he is usually free from attacks of marked dyspnea and suffocation, but during his sleep the attacks appear and usually awake him in the early morning hours; this type of asthma most usually develops during or past middle age.

The sequence of events which takes place in these two types of attacks of atypical asthma or asthmatic bronchitis is as follows. The bacterial infection in the bronchi causes the usual type of bronchitic sputum which may be thick, but it is not very tenacious or jelly-like, and it is raised with little

difficulty and ordinarily when the patient is not sleeping. At times, however, the sputum becomes very tenacious and jelly-like and it clings so tenaciously to the lumen of the bronchi that repeated coughs may fail to remove it. The stimulus to coughing, however, is so great that the patient repeatedly coughs, and the more he coughs the more dyspneic he becomes until finally the tenacious secretion is raised, after which the patient rapidly becomes free from dyspnea. There is probably a slight constriction of the bronchial muscles, since the inhalation of fumes from antispasmodic remedies is followed by the raising of sputum and consequent relief from dyspnea. These drugs release the muscular constriction, thus leaving the secretion unattached. This muscular constriction, however, is not as marked as it is in the typical bronchial asthma as first described, neither is it caused by protein irritation of the nerves supplying these bronchial muscles. The cause of this slight muscular constriction in the atypical cases probably results from local irritation due to the protracted spell of coughing or less likely it is due directly to the irritation of the tenacious sputum. The dyspnea in these attacks is chiefly inspiratory in type and is due partly to the unproductive cough, and partly to the narrowed lumen of the bronchi; this narrowed lumen is due partly to slight muscular constriction and partly to the coating of tenacious mucus superimposed upon the constricted mucus membrane of the bronchi. After the acute attack has subsided, the patient is not entirely free from symptoms; he still has more or less cough and expectoration until another attack occurs; this may be a few hours later or not until the early morning hours of the next night. The duration of the attacks may be a few minutes but more commonly it lasts an hour or two, and frequently the patient may continue in a more or less acute attack for several days. These attacks are frequently accompanied by a little fever and a slightly elevated pulse rate.

Physical examination of patients afflicted with this atypical type of bronchial asthma reveals during the interval between attacks, signs of chronic bronchitis and emphysema. During the attacks the dyspnea is chiefly inspiratory in type, although both inspiration and expiration are prolonged, but the patient manifests the greater effort on inspiration; and in addition

to the wheezing and dry rhonchi there may be heard coarse bubbling râles in the bronchi. The patient himself describes the dry râles as whistling and the wet râles as rattles. Fluoroscopy of the chest during the attack reveals a diaphragm fixed in about the normal position, midway in its greatest excursion, thus indicating no great amount of distension of the lungs. The lung vital capacity is low in these cases between the attacks at a time when the patient is most free from symptoms; this indicates a state of permanent emphysema.

Pathology so far has revealed, with the exception of peribronchial thickening, nothing in addition to what may be determined on physical examination. By animal experimentation, Oftedal[7] has demonstrated an elective affinity to bacteria (streptococci) for the bronchial musculature; the streptococci were obtained from the sputum of patients who had the atypical type of bronchial asthma.

If all cases of bronchial asthma could be placed as easily in either of the two groups as already described, namely, typical and atypical, the disease would now be comparatively simple from the standpoint of cause, prevention and treatment. Unfortunately this is not the case. The description of the atypical variety holds for all cases of that type in that it is a chronic condition from the beginning; the patient's symptoms are no different after he has had the disease for years than they were with the first attack. The true or typical bronchial asthmatic, when the condition develops during childhood or thereafter, presents the typical attack as already described until, because of frequently repeated exposure to the causative protein, he has frequently repeated attacks. Frequently repeated attacks sooner or later cause so much bronchial irritation that bacterial infection gets a hold and a resultant chronic bronchitis is superimposed upon a true bronchial asthma. When this occurs the patient may present symptoms closely simulating the atypical variety. The history, which may be elicited from the patient, describing the onset and the first attacks of the condition, will aid in determining the kind of asthma, and the cutaneous or skin test will definitely determine the kind of asthma.

Determination of Protein Sensitivity. There are several methods of determining whether a patient is sensitive to a protein or not. One way which is used more or less is the intradermal or intracutaneous injection of the protein; there are, however, some objections to this method and it tends to be too delicate if non-specific. A test which is used more extensively and which is very reliable is the cutaneous or skin test, which is performed in the following manner. A number of small cuts, each about an eighth of an inch long, are made on the flexor surfaces of the forearm. These cuts are made with a sharp scalpel, but not deep enough to draw blood, although they do penetrate the skin. On each cut is placed a protein and to it is added a drop of tenth normal sodium hydroxid solution to dissolve the protein and to permit of its rapid absorption. At the end of a half-hour the proteins are washed off and the reactions are noted, always comparing the inoculated cuts with normal controls on which no protein was placed. A positive reaction consists of a raised white elevation or urticarial wheal surrounding the cut. The smallest reactions that we call positive must measure 0.5 cm. in diameter. All larger reactions are noted by a series of plus marks and any smaller reaction is called doubtful. As evidence that the skin test is satisfactory and conservative, we have found by treatment with subcutaneous injections of proteins that we cannot inject a patient with a stronger solution of a protein than that which gave a positive reaction without provoking an attack of asthma; and that a series of treatments with weaker solutions, which failed to give a positive skin test, produces no benefit.

The cutaneous or skin test, therefore, separates true or typical bronchial asthma from the atypical or asthmatic bronchitis. The patient with the typical variety gives a positive skin test with proteins and is, therefore, sensitive to those proteins which are the direct cause of the asthma, whereas the atypical variety fails to give a positive skin test with proteins, thereby excluding proteins as a direct cause of asthma. Rarely one will test a patient who reacts positively to every protein tried, but the normal control cut will also be positive, so that such positive reactions must be discounted. False positive reactions in such patients that react to all skin cuts are due to temporary ir-

ritability of the skin, since at another visit, later on, the skin tests may be done satisfactorily. Fortunately such cases are rarely encountered. Frequently patients give a positive skin test with one or more proteins, that have no bearing on the cause of the asthmatic condition, but these proteins are the cause of eczema, urticaria, or hay fever, conditions which complicate and are associated with asthma in those particular individuals. Occasionally a patient is met with who gives a positive skin test with a protein that apparently has no bearing at all on that patient's condition. A case in point is worth mentioning.

A woman, who was sensitive to the protein of cornmeal and *Staphylococcus pyogenes aureus,* never ate cornmeal, and treatment with vaccines of *Staphylococcus pyogenes aureus* relieved the bronchial asthma for many months; then the attacks reappeared worse than ever. Treatment with the vaccine, however, brought no benefit. On account of the conservation of wheat flour during the war this patient had to eat substitutes, and she was eating cornmeal bread freely without thinking about the opposite skin test with that protein. On being reminded about that positive test she omitted cornmeal from her diet and the attacks of bronchial asthma stopped and have not returned.

Another rare type of patient is one who gives a positive skin test with a protein but is able to eat sparingly or moderately that particular protein without having symptoms, but when that particular protein is eaten in excessive amounts attacks of bronchial asthma result. Therefore positive skin tests by proteins, which seem to have no bearing on the cause of asthma, should be considered as danger signals and not as false reactions; such positive tests should not be disregarded. Absolute omission of a food from the diet for some time often changes a positive skin test to a negative or only slightly positive test. This is important to bear in mind, since, sometimes, the evidence is so strong that a food causes symptoms that that particular food is omitted from the diet before skin tests are made; then a negative skin test is obtained with that food and that is misleading. Therefore, when testing with food proteins, the patient should be eating them; and slightly positive reactions should be repeated at another time.

For practical purposes the following kinds of proteins should be used routinely in the skin tests. The protein and the peptone of horse hair or dandruff, cat hair, dog hair, feathers; the pollens of June grass and timothy; the common foods such as egg, casein and lactalbumen of milk, the globulin, gliadin and glutenen of wheat, the whole protein of the other cereals, the meats, chicken, potato, peas, beans and any other food proteins that the patient is accustomed to eat frequently. Occasionally the patient's history, occupation or surroundings may lead one to suspect some other common or even unusual type of protein. In horse hair sensitive cases it is of interest to test with horse serum protein in anticipation of future antitoxin treatment. In the writer's experience only twenty per cent. of the horse hair sensitive patients were sensitive to horse serum so that probably a very small percentage of asthmatics are sensitive to horse serum and the danger of injecting an asthmatic with moderate amounts of horse serum, such as antitoxin, is confined to only a rare case.

Entry into Body of Proteins Causing Asthma. The sources through which proteins that cause bronchial asthma enter the body are inhalation, ingestion, absorption, and infection. Inhalation takes place through the respiratory tract and chiefly concerns the protein in the pollen of plants, in the emanations and hair of animals, in the flour of cereal grains, and in organic dust. Ingestion has to do with the protein in food, and we know that foods, after entrance into the gastrointestinal tract, do cause asthma. Absorption apart from inhalation and ingestion, concerns the conjunctivæ and, to a less extent, the skin. By infection we mean the presence of pathogenic bacteria in any part of the body, but more especially foci of infection located in the teeth, tonsils, nose, throat and lungs. In the case of bacteria we have to deal with the protein element as well as with the infectious element. The skin test has to do only with the protein element, so that even though bacteria give a negative test, they may still be a cause of asthma through their infectious nature, and the patient need not be sensitized to bacterial protein. Through inhalation the protein acts as an irritant on the peripheral endings of the constrictor nerve fibers; through ingestion and absorption the incompletely digested proteins or the amino-acids, by circulating

in the blood stream, probably act upon the central end of the constrictor nerve fibers; and through infection the bacterial protein may act either or both ways.

CLASSIFICATION OF CAUSES OF BRONCHIAL ASTHMA.

By means of the cutaneous or skin test the causes of bronchial asthma may be classified in the following manner and the true or sensitive type may be separated from the atypical non-sensitive type or asthmatic bronchitis.

BRONCHIAL ASTHMA

Sensitive to proteins		Not sensitive to proteins	
Asthma throughout the year due to { animals food bacteria	Seasonal asthma due to pollens	Asthma throughout the year due to bacteria	Seasonal asthma due to bacteria
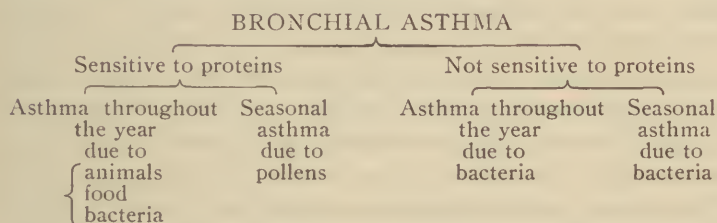
Typical bronchial asthma is chiefly met with in infancy, childhood and young adult life; when typical bronchial asthma develops during adult life, occupation usually has a direct bearing upon the cause. Asthmatic bronchitis is the usual type of asthma that occurs in adults and occupation may determine the cause in these cases.. Bakers not infrequently become sensitized to the cereal grains with which they work through the inhalation of the dust from the flour. Hostlers and those that are intimately associated with horses and other animals are apt to become sensitized to the dandruff or hair proteins of animals. Sensitization to the hair or feather proteins of domestic and pet animals is not uncommon among adults. Unusual occupations may be the source of sensitization, as, for example, the writer has treated one patient who became sensitized to the protein of green coffee bean while his occupation was that of sifting the green beans; another man whose work was that of a jewel polisher became sensitized to the protein of orangewood dust; two men who were jewel polishers became sensitized to the protein of boxwood dust with which they worked. Occupational sensitization causing typical asthma should always be considered.

Asthmatic bronchitis is more frequently dependent upon oc-
cupation because of the necessary exposure of the patient to
undesirable elements. The writer has observed several pa-
tients with asthmatic bronchitis among fur dyers that had at-
tacks only when exposed to the fur dyes. Gerdon[8] has studied
seven cases of asthma among dye workers and concludes that
the patients are sensitized to ursol-dyes; he quotes Criegern
who studied forty cases of asthma in whom p-phenyldiamin
caused not only asthma but eczema and irritation of the air
passages, the mere odor of the dye caused asthma. The writer
prefers to call such cases as instances of bronchial irritation
rather than sensitization. Stone and marble cutters sometimes
have asthma caused by the inhalation of fine particles of stone
and marble dust. Coal miners not infrequently have asthma
from exposure to dampness, bad air, coal dust and gases. In-
halation of some of the gases which were used in the late war
have resulted in asthma. Any occupation which necessitates
sudden changes of temperature and undue exposure without
the opportunity of additional protection in clothing may pre-
dispose to asthmatic bronchitis, which may be considered as a
severe form of bronchitis. In all of these instances the writer
considers that the chief cause of asthma is bacterial infection
in the bronchi as a result of previous and severe or long con-
tinued bronchial irritation plus lowered bronchial resistance.

So far in this section, only the primary or direct causes of
bronchial asthma have been mentioned. There are, however,
secondary or contributory causes of minor importance; they
are secondary and of minor importance because after treatment
with the proper protein to which the patients are sensitive, or
if not sensitive, after proper vaccine treatment, patients usu-
ally become tolerant to such conditions and may be exposed to
them without having asthma. Patients with bronchial asthma
associate attacks with cold air, dampness, changeable weather,
winds, going from hot room to cold room and *vice versa*,
menstruation, indigestion, biliousness, distension of gastroin-
testinal tract, overfilling of stomach, nervousness, irritability,
being over tired, excitement, dust, irritating odors and gases,
colds and bronchitis, and, in fact, anything that is not in perfect
accord with the particular individual subject to asthma. The
explanation for these minor causes is that the patient who has

had frequently repeated attacks of bronchial asthma or asthmatic bronchitis, has, as a result of these attacks, a very sensitive, delicate, or easily upset respiratory tract and mechanism, and the least deviation from the narrow limits of each particular case is apt to precipitate an asthmatic attack. The vital capacity of the asthmatic is greatly reduced. As one theory puts it, there is an unbalance of the autonomic nerve system; but whatever the condition may be, it is usually restored by proper treatment, which removes the primary causes that have been discussed at length throughout this paper. Although neurasthenic, neurotic, and psychoneurotic conditions are frequently associated with bronchial asthma, these conditions are usually the result of bronchial asthma, and although rarely they may be the cause, they are not sufficiently often the cause to warrant a place among the causes of bronchial asthma. There seem to be two types of colds and of bronchitis, one of which is anaphylactic, the other due to bacteria. Relief or freedom from the first type follows proper treatment with proteins. Frequently vaccines relieve and prevent the other type. Adenoids, infected tonsils, teeth and sinuses, catarrhal conditions and infections in any part of the body may be primary causes of bronchial asthma or they may be secondary causes by lowering the individual's resistance to bacterial infection in the bronchi. This must be borne in mind, and such conditions should be remedied on general principles and for the general health of the individual. Shivdas[9] has found pyorrhea alveolaris to be a cause of bronchitis and asthma, and proper treatment of the condition resulted in marked improvement or disappearance of the lung condition.

Prognosis, with proper treatment, is excellent in the sensitive cases, provided the patient has not a very chronic bronchitis or marked emphysema. The age of onset of asthma, the duration of asthma, and the age of the patient, when treated, do not modify the prognosis in the sensitive patient. With the non-sensitive bronchitis type, however, the older the patient is when asthma begins and the older he is when treatment is begun, the more unfavorable the prognosis from vaccine treatment. The severity of the bronchitis, the degree of emphysema, and the resistance of the individual to bacteria all modify the prognosis in the non-sensitive type. The sen-

sitive type probably never dies in an attack and the non-sensitive type rarely dies in an attack. Neither does either type of case outgrow or spontaneously become cured of asthma; when such results seem to occur, they are actually due to the removal of the offending protein, to a change in the patient's environment, or to an increased resistance on the part of the patient toward certain bacteria which were causing the symptoms. Acute infections have no effect in the sensitive type, but in the non-sensitive bronchitis type they may temporarily relieve attacks or they may precipitate attacks. The incidence of pneumonia and tuberculosis is no greater in the asthmatic than in any other chronic disease, neither does asthma predispose to these diseases. Although the elasticity of the lung in an asthmatic after a time becomes impaired and thus makes the prognosis more unfavorable, the integrity of the myocardium is rarely weakened.

DIFFERENTIAL DIAGNOSIS.

Although an attempt has been made to define clearly in this article what is meant by bronchial asthma and asthmatic bronchitis, a differential diagnosis may be necessary. In laryngeal and tracheal obstruction the dyspnea is inspiratory and the stridor of the inspiration instead of the wheezing of asthma serve to differentiate these conditions. The diagnosis of acute bronchitis from asthma in very young children is difficult, as already mentioned; the skin test is of the greatest importance because, if positive, and it is positive with some protein in four-fifths of the cases who later on develop asthma, the bronchitis should be considered as an early symptom of bronchial asthma. Emphysema past middle age produces symptoms similar to asthmatic bronchitis, but the age of the patient and the degree of emphysema will differentiate. Asthma and emphysema frequently coexist. Enlarged bronchial glands in children may give rise to dyspnea, but the thoracic dullness, irregular fever, and night sweats aid in making the proper diagnosis. Mediastinal tumors and aneurisms of the arch of the aorta, by compressing the trachea or left bronchus, may give rise to paroxysmal dyspnea, cough and secondary bronchial infection, all of which together simulate asthmatic bronchitis. The brassy cough, tracheal tug, substernal dullness,

and heaving impulse serve to diagnose aneurisms, and the substernal dullness, Roentgen ray, and fluoroscopy will differentiate tumors. A foreign body in the bronchus may be suspected from the patient's history. In hysterical dyspnea both inspiration and expiration are short and there is no real dyspnea. In chronic fibrinous bronchitis, which is a rare condition, the symptoms closely simulate asthmatic bronchitis, with the exception that there is marked cyanosis during the dyspneic attack and the sputum at times consists of nothing but bronchial casts. An enlarged thymus in children may cause dyspnea. Localized foci of tuberculosis in the bronchial glands may break down and cause peribronchial thickening or even an inflammatory process in the bronchioles upon which is developed a secondary infection which may give rise to symptoms simulating asthmatic bronchitis. Pierson[10] has observed such instances, but they are not frequent. As a rule, it ought not to be difficult to differentiate tuberculosis and asthma. Paroxysmal cardiac dyspnea consists of a quick, panting respiration and an important factor in its cause is diminished vital capacity of the lungs (Peabody),[11] and renal dyspnea is probably due chiefly to an acidosis (Peabody)[12]; neither condition should be called asthma; the patient's history and a physical examination should determine the diagnosis. Asthma may complicate both cardiac and renal disease, but the asthmatic condition is entirely separate from the other two; in other words, true cardiac and renal asthma probably do not exist.

TREATMENT OF ASTHMA.

The treatment of bronchial asthma consists of the following kinds: preventive, drug, specific protein, vaccine, non-specific protein, operative precedures, climatic and supportive; of these the specific protein and the vaccine treatment are of prime importance. Naturally sensitization cannot be prevented in the human. However, when an infant or child has symptoms of recurrent colds and bronchitis which fail to yield to ordinary medication, that person should be tested for sensitization. Neither should colds nor bronchitis be neglected in adults. In the future there need be no excuse for not giving a person who develops asthma due consideration early in the disease,

rather than, as has been the custom in the past, allowing such individuals to drift along in a neglected way.

Drug Treatment. The drug treatment of bronchial asthma is most disappointing. In the asthmatic bronchitis type potassium iodide in 0.6 gram (10 grain) doses three times a day is of considerable service. This drug thins the secretion in the bronchi, thus enabling the discharge of an otherwise thick, tenacious sputum, which, when not easily raised, causes choking up, severe coughing spells, and asthmatic attacks. In other words, potassium iodide favors free drainage from the bronchi with slight effort. This drug, however, does not benefit the sensitive type of asthma, which is not complicated by severe bronchitis. The incorporation of small amounts of codein with the potassium iodide is serviceable in allaying undue irritation. The most reliable and yet the most harmless drug that temporarily relieves the acute attacks of either type of asthma is epinephrin. This is obtained as adrenalin chloride 1 : 1000 (Parke, Davis & Co.) and should be administered subcutaneously in one-half to one cubic centimeter doses for adults, repeated as often as necessary. This drug should not be given intravenously nor intramuscularly, and large doses should be avoided in children, with whom 0.2 to 0.3 c.c. suffices as a rule. Next to adrenalin chloride, atropin subcutaneously in large doses is preferable. Since the patient himself cannot use hypodermatic medication, he tends to rely upon patent medicine and so-called asthma cures. The most serviceable among these seem to be the ones that contain stramonium leaves and saltpeter in the form of a powder, the fumes of which when burned are inhaled for the relief of the paroxysm. These fumes seem to be anti-spasmodic in action and following their inhalation thick sputum is raised and temporary relief results. Many other drugs might be mentioned, but they are less reliable.

Specific Protein Treatment. Absolute omission of the offending protein is entirely satisfactory and not nearly as difficult as might be anticipated. This problem is sufficiently important to warrant considerable detail. Patients who are sensitive to potato usually are able to eat baked potato even though boiled potato causes symptoms. Although raw milk may cause symptoms, boiled milk will not, and cream and

butter, both of which practically consist of only the fat in milk, may be taken. Shredded wheat biscuits and thin slices of bread well toasted on both sides may be eaten, even though the patient is sensitive to wheat. The explanation for these variencies is that very high temperatures destroy the anaphylactic properties of proteins. Probably the only common food protein which cannot be treated is that of egg, because heat sufficient to destroy its anaphylactic property would render it non-palatable and indigestible. Furthermore not all of the individual proteins that constitute a food cause symptoms in the same person, and some individual proteins which do cause symptoms may not be present in certain food in sufficient amounts to cause symptoms; such examples follow. In rice the only protein present in appreciable amounts is oryzenin (six and five-tenths per cent.) ; in oat, glutelin represents eight per cent. of the protein, whereas avenalin and prolamine each represent one and five-tenths per cent. or less of the protein; in corn, zein is the chief protein (five per cent.) ; in whole wheat, gliadin and glutenin each make up four per cent., whereas in the embryo wheat, proteose, globulin, and leucosin are present, respectively in three, five and ten per cent. The importance of doing skin tests with these individual proteins in the cereals is evident, and in the case of rice, if the patient were not sensitive to oryzenin he could probably eat rice without trouble, since the other proteins are present in rice in too small amounts probably to cause trouble. Usually the same patient is not sensitive to all of the cereals, so that if wheat must be omitted other cereals may be substituted. Often patients are able to eat small amounts of the offending protein, whereas large amounts cause symptoms; this fact has been proven to be true by Schloss and Worthern[13] and by Talbot.[14] Schloss and Worthern found the gastrointestinal tract of infants to be permeable to undigested protein when taken in large amounts, and Talbot found a threshold below which the eating of protein caused no symptoms, but as the threshold was approached symptoms began to appear. These facts evidently apply to some adults, since the author, by doing bismuth gastrointestinal studies on patients who were sensitive to wheat proteins, found abnormalities in the tract, such as ptosis, fixations, kinkings, and the like, which favor stasis and

premature absorption at such points. Therefore, for all of these reasons, and more especially because of the permeability and abnormalities of the intestinal tract, omission of or at least the careful feeding of the offending protein is by far the most reasonable treatment of food asthmatics.

Bronchial asthma caused by animal emanations is very successfully treated by subcutaneous inoculations of the offending protein. Before this treatment can be given, however, skin or cutaneous tests must be done with varying dilutions of the particular protein in order to find out the initial therapeutic dose. These dilutions may be made with one-hundredth normal sodium hydroxide, and a useful series of dilutions consists of 1 : 100, 1 : 1000, 1 : 10,000, 1 : 100,000 and 1 : 1,000,000 (one part protein diluted one hundred times, and so on, with N/100 sodium hydroxide). Patients who are sensitive to animal hair proteins in a dilution of 1 : 10,000 and 1 : 100,000, and these are the usual dilutions to which patients are sensitive, surely should be treated. The first treatment consists of 0.1 c.c. of the strongest solution that fails to give a positive skin test and each week the dose is gradually and slowly increased until about one cubic centimeter is given; then the next stronger solution is given, first 0.1 c.c. and gradually and slowly increasing up to the maximum amount before the next stronger is given, and so on. As the amount of treatment progressively increases, the positiveness of the skin test progressively diminishes until, if treatment is carried on long enough, the skin test becomes negative with concentrated protein and the patient becomes absolutely desensitized. Improvement usually is noted after three or four doses, sometimes not until after eight or ten doses and in an occasional case, where there is an extensive bronchitis, vaccines are required in addition to the particular protein. The above treatment is given to horse, cat, and dog cases, but with those who are sensitive to feathers, wool, and the hair or fur of other animals, it is easier to avoid these than to treat with their protein.

Pollen asthmatics are tested and treated in a similar way, with the exception that such high dilutions are not required, and treatment should in these cases, be given preceding the pollen season rather than during the pollen season. The usual pollen protein dilutions and the amount of each dilution for

treatment follows: 1 : 10,000 give 0.1 c.c.; 1 : 5000 give 0.1 c.c., 0.2 c.c., 0.3 c.c.; 1 : 1000 give 0.1 c.c., 0.2 c.c.; 1 : 500 give 0.1 c.c., 0.2 c.c., 0.3 c.c., 0.4 c.c.; 1 : 100 give 0.1 c.c. and 0.2 c.c.

Patients who are sensitive to bacterial proteins are treated with vaccines of that particular organism, the first dose being small, usually 200 million, and thereafter gradually increasing the dose. As much care is required to gradually increase the dose of vaccine as is required in the animal cases, and in either case, if a particular dose causes much reaction, that same dose should be repeated before giving an increased amount.

The treatment of multiple sensitization or of those who give positive skin tests with several types of proteins is a matter of judgment. Patients who are sensitive to several types of animal hair should be treated with that type which gives the strongest reaction or with that type to which they are most intimately exposed. With patients who are very sensitive to animal hair and are also sensitive to food protein, the latter should surely be omitted and treatment with the former is usually indicated as well. Those sensitive to pollens should always be treated, even though food and animal proteins are also the cause. When bacterial proteins complicate the situation vaccines of such bacteria may be required.

Specific protein treatment, as outlined above, will relieve bronchial asthma in at least eighty per cent. of the sensitive cases, and in another ten per cent. of such cases proper vaccines, either alone or in conjunction with protein treatment, will relieve attacks.

Reference has already been made to the occasional necessity of treating sensitive cases who have marked bronchitis with autogenous vaccines made from the sputum. With the non-sensitive or asthmatic bronchitis type of case, autogenous vaccines are the best mode of treatment, and good results follow their administration in at least two-thirds of the cases, provided the proper organism is given. In making autogenous vaccines, thick masses of sputum, which are raised at the end of an attack or come from the smaller bronchi, are washed in sterile saline solution, shaken in bouillon, and plated on blood agar. From the blood agar plates the predominating organism may be selected. Less favorable but very good results follow from inoculating and growing the washed sputum in dextrose

bouillon, and from this is made a vaccine consisting of all of the organisms present. If the patient has a more troublesome nasal secretion or catarrhal condition of the nose and throat, vaccines may be made from this source. In the author's experience Streptococcus hemolysans is the usual organism which gives good results, and next in order of frequency come Staphylococcus pyogenes aureus, Streptococcus viridans, diphtheroid bacilli, and Staphylococcus pyogenes albus. Occasionally other types of organisms are found to be prevalent and to be needed as a vaccine. There is a specificity among bacteria as well as among proteins in the treatment of asthmatic conditions so that, if one type of organism fails to benefit, other autogenous types should be tried in the form of a new vaccine. With the non-sensitive cases, the older the patient is when asthma begins and the older he is when vaccine treatment is begun, the more unfavorable the prognosis; age to a certain extent is an index to individual resistance. The permanency of relief from vaccine treatment in the non-sensitive cases depends on the individual's resistance to the bacteria in question; therefore, the duration of relief from asthma varies. Some patients continue free from asthma for many months after vaccines are discontinued, others for only a month or two, and some patients require the constant use of vaccines to be free from asthma. Succeeding courses of vaccine treatment, provided that there has been no change in the bacteria which are causing the relapse, seem to relieve more promptly than the first course of vaccine treatment; when a relapse is not relieved by a second course of vaccines which previously did relieve, other bacteria should be suspected as the cause of asthma and new vaccines should be made.

Non-specific Protein Treatment. As in most chronic infections intravenous foreign protein treatment may be of benefit, the same may apply to the asthmatic patient. Auld[15] reports good results from the intravenous injection of peptone. Such a procedure is liable to cause ill effects if the patient should happen to be sensitive to that or a closely related protein. Naturally non-specific treatment does not throw any light on the actual cause of the disease.

Operative Measures. Although bronchoscopy and intratracheal treatment is not essentially an operative procedure,

it is sufficiently removed from the clinician's armamentarium to warrant the consideration of it along with operative procedures. De Levie[16] incriminates spasm of the bronchial muscles as the cause of asthma and ascribes the spasm to overexcitability of their innervation. He therefore anesthetizes the bronchi by spraying them through a bronchoscopic tube with novocain and epinephrin. Cases having much secretion from bronchitis were not benefited because, as he thought, the secretion prevented the spray from reaching the mucous membrane of the bronchi. This observation completely confirms the author's theories, which were presented at the beginning of this article. The true or typical attack of bronchial asthma is caused by muscular spasm, whereas in the atypical or asthmatic bronchitis type tenacious secretion is the chief cause. Syme[17] in a similar manner applies locally silver nitrate to weaken the irritability of the mucous membrane and nerves.

Operations will not benefit those who are sensitive to proteins; therefore the cutaneous test should be done first. In the non-sensitive cases operations·on the nose and sinuses should be done only from the standpoint of seeking better drainage in the sinuses and removing obstruction to the access of air in the nasal cavities. The same applies to dentistry. Of course diseased tonsils, adenoids, and nasal spurs require removal. Vaccines made from the infected areas at the time of operation are often a great adjunct and often are required to entirely clear up the infected area. Operations in other localities may be of great benefit to asthmatics. Babcock had an asthmatic patient with gall-stones and an infected gall-bladder; after operation the patient was free from asthma while the gall-bladder freely drained, but when there was a stoppage of drainage asthma returned; finally, with cure of the condition, asthma disappeared. The author has observed a case who developed asthma soon after he developed a hernia, but asthma disappeared when the hernia was repaired. The same patient developed a hernia in the other groin and again asthma appeared, but following repair the asthma again disappeared and has not returned. In the author's case the condition was one of asthmatic bronchitis, so that probably the herniæ were sufficient to lower the patient's vitality to the infecting bronchial bacteria.

Climate. Change of climate does not benefit the sensitive type of patient, with the exception of the pollen cases, with whom the change is in reality from a place where those particular pollens are prevalent to a place where they are absent. In a similar way a patient may move from close proximity to a stable to a place more distant. With the non-sensitive or asthmatic bronchitis type of case a change of climate occasionally benefits or relieves attacks; even moving for a short distance, as from low ground to high ground and *vice versa*, may relieve; but such instances are not common. Florida is a suitable place for an occasional case, Arizona for still another, California for a third, and so on, but no one of these states or climates is suitable for all three; it is an expensive experiment and usually a poor investment.

Supportive Treatment. Rarely one meets with sensitive cases and frequently one meets with non-sensitive cases who do not improve under what is probably the proper treatment according to experience. It is these patients that require supportive treatment, such as tonics, rest, proper diet, restrictive exercise, fresh air, and hygienic measures. In such cases it is necessary to remove the burdens and handicaps before the patient is able to respond to proper specific treatment.

THE CAUSES AND TREATMENT OF SEASONAL HAY FEVER.

Although the pollens of plants have long been recognized as the cause of seasonal hay fever and many methods of treatment with pollens have been described, there is need to emphasize the fact that successful treatment of hay fever with pollens depends upon two factors. The first of these is the accurate determination, by means of history and skin tests, of the specific pollens to which the patient is sensitive, and the second is adequate treatment only with those pollens to which the patient reacts. Almost any one of the large number of plants to which the patients are exposed may in rare instances cause hay fever, but in reality only those plants that shed great quantities of light pollens which can be blown to a distance by the wind are found to be common causes of hay fever. Since the wind-borne pollen is present in the atmosphere in

great abundance, it may cause hay fever in sensitive patients who do not come into direct contact with the plants, and the only way of protecting such patients against the wind-borne pollens which they inhale is by treatment with extracts of the pollens to which they are sensitive, or by sending them during the hay fever season to a locality where the plants do not grow. Rare plants, plants which are pollinated by insects, and those which produce small amounts of pollens, cause hay fever only when the patient comes into direct contact with the flowers. Therefore, treatment with these pollens is rarely necessary because the patients can easily avoid the cause of the symptoms. Since the flora varies greatly in different localities and different seasons, it is essential for the physician who treats hay fever to know the distribution and the seasons of pollination of the plants indigenous in the territory where his patients live, what plants are most common, which are wind-pollinated, and at what time the pollen is shed. In securing this information the co-operation of a field botanist who is familiar with the plants of the region is of value. With knowledge of the pollen habits of plants, most pollens are at once eliminated as probable causes of hay fever, and only those plants which produce pollen in abundance during the hay fever season, or to which the patient is directly exposed, need be considered.

By a careful history of the seasonal occurrence of the patient's hay fever, further elimination of probable causes can be made, because usually the time during which the patient has hay fever corresponds closely with the season of pollination of a plant or group of plants that is known to be the common cause of hay fever in that locality at that time of the year; this indication as to the cause of the symptom can then be verified by the skin tests with the pollens in question. The age of onset, the number of years' duration of hay fever symptoms, and the sex of the patient do not have any bearing on the frequency, the cause, or the treatment of the condition.

In New England, there are three distinct seasons of hay fever which correspond with the periods of pollination of the groups of plants that are the common causes of hay fever in that locality. The earliest hay fever season, extending from the middle of March to the middle or last of May and in late

seasons through the first week in June, is caused chiefly by the pollens of trees.   Beginning with the pollination of the hazelnut and witch hazel about the middle of March, pollen is shed in late March and April by the willow, the poplars, the junipers, maples, birches, and elms, and in May by the sweet fern and bayberry, the ashes, oaks, sycamore, hickories and walnut, alder and the various fruit trees, and by the pines in late May or early June.   The writer has observed twelve patients who were sensitive to and had hay fever from the pollens of trees.   One patient had hay fever caused by the pollens of apple blossoms and was free from symptoms following pre-seasonal treatment with apple pollen extract.   One patient who was sensitive to the pollen of the oak and maple, and another who was sensitive to willow pollen were both free from symptoms following treatment with these pollen extracts. Other patients were sensitive to tree pollens : one to poplar pollen, one to willow, two to ash, two to both willow and pop-lar, and one to willow, poplar, and ash.   One patient who every year has hay fever for a single day late in May at a time when he drives through the pine woods, was sensitive to pine pollen.   Since cases of this very early hay fever are compar-atively rare, and the symptoms last usually from three or four days to two weeks at most, according to the period of pollina-tion of the tree to which the patient is sensitive, it does not seem essential except in isolated cases to give treatment with tree pollens.   The tree pollens to which patients usually give positive reactions and with which it is most frequently desir-able to treat, are the willow, poplar and maple.

The second season of hay fever, usually called early spring hay fever or rose cold, extends in New England from the mid-dle or last of May to the middle of July, and the principal cause is the pollen of the grasses.   Other plants such as dande-lion, buttercup, daisy, and sheep sorrel pollinate at this time, but with the exception of daisy, no patient when tested has been found sensitive to these pollens, and if they ever cause hay fever is by direct smelling of the flower.   Still other plants such as plantain, pigweed, smart weed, pepper grass, clover, and dock blossom during this season, but the amount of pollen produced is so small that it would be difficult to col-lect, and it is too small in amount to cause symptoms.   Rose

which pollinates at the time of early hay fever rarely causes hay fever because it produces little pollen and is pollinated by insects. Many persons who have early hay fever suspect that rose is the cause because it is the conspicuous flower at this time, and for this reason skin tests must frequently be done with rose as well as grass pollen in order to satisfy the patient. Of thirty-five patients tested with rose pollen at their own request, thirty-one failed to react more strongly than what is called a doubtful reaction to the pollen of either red or white rose, and two who did give a positive skin reaction to the whole pollen did not react at all to a 1 : 100 dilution of rose pollen. One patient who was about equally sensitive to the pollens of three grasses and to rose pollen was practically free from symptoms following treatment with equal parts of red top grass and rose pollen extract. A second patient who was sensitive to rose pollen only was free from symptoms following treatment with rose pollen extract; this freedom from symptoms was repeated the following year when a second course of treatment with rose pollen extract was given, even though she was a nurse in a hospital where she had to be intimately associated with roses. A florist who had hay fever at any time of year, whenever he worked in a rose-house, was sensitive to rose pollen only and was free from symptoms following treatment with rose pollen extract. In the four years during which grass cases were tested and treated, only two true rose cold cases were encountered, and for this reason it would seem that in New England roses are rarely the chief cause of early hay fever.

The grass pollen which is the principal cause of hay fever in New England during June and July is produced in abundance, is light, and is carried far by the wind. One of the earliest grasses to pollinate in May is lawn grass, the short slender grass of cultivated lawns, but since hay fever rarely starts early in May lawn grass in all probability rarely causes hay fever. Lawn grass continues to pollinate at intervals throughout the summer, and in patients who are sensitive to many grasses and who are not sufficiently treated with one grass pollen to protect against others, lawn grass pollen probably aggravates the hay fever symptoms. Orchard grass and many other grasses pollinate in June and July, each at its own par-

ticular season, but most of these grasses are not commonly encountered. The same thirty-five patients who were tested with rose pollen were also tested with orchard grass; thirty failed to give positive skin tests with the whole pollen, and the five patients who reacted positively to the whole pollen gave no reaction to the 1 : 100 dilution of the pollen extract, and hence were not sensitive enough to it to have hay fever from exposure to orchard grass pollen. These tests indicate that orchard grass (Dactylis glomerata) is rarely the cause of hay fever.

Corn, a member of the grass family, pollinates in July, and is a possible cause of early hay fever, especially in those who cultivate and gather it and to a less degree in those who eat it, since a small amount of pollen clings to the husks. Of fifty cases treated for early hay fever and tested with corn pollen, twenty-two failed to give a positive skin test with the whole pollen, and of the eighteen who reacted positively to the whole pollen, all failed to react to the 1 : 100 dilution. The individual granule of corn pollen is very large and heavy, and it falls rapidly from the tassel at the top of the corn stalk to the tips of the ears which it is to fertilize, and it cannot be carried more than a few feet by the wind. Hence intimate exposure is necessary for corn pollen to produce hay fever, and treatment with corn pollen is usually not essential, because the patient, unless he is a grower of corn, can easily avoid it. For this reason corn can practically be eliminated as a cause of hay fever except in localities where large fields of it are grown, and this is likewise true of the other grains, namely wheat, oat, barley and rye, which may be factors of importance in the grain growing regions of the west.

By a careful analysis of the history of the patients, the early hay fever season is subdivided into two shorter but distinct periods; the first is the three weeks, during late May and the first two weeks in June and the conspicuous grass in pollination at this time is June grass (Poa pratensis) which sometimes begins to pollinate as early as the middle of May and stops by the middle of June, a few days to a week before the second and longer period of early hay fever starts. A second period begins about the middle of June and continues for six weeks until the middle or end of July, and the chief grasses in

pollination during this time, June and July, are red top (Agrostis alba) and timothy (Phleum pratense). Patients with early hay fever must be tested, therefore, with the pollens of these three grasses. Those who have hay fever only during June may be expected to react more strongly to June grass and less strongly or not at all to red top and timothy. Patients who have hay fever in late June and July tend to react to both timothy and red top, usually more strongly to timothy, and less strongly to June grass. Patients who have hay fever from late May to the middle or end of July usually react positively to all three grasses. Therefore, as has already been stated, patients with early hay fever should be tested with the pollens of the three grasses, timothy, red top and June grass, and with rose pollen, since an occasional patient is more sensitive to one of them rather than to timothy, but about ninety per cent. of the early hay fever cases can be treated satisfactorily with timothy pollen extract alone.

In regions outside of New England the exact times of grass pollination, and even the species of grass with which it is essential to treat may be different, although one patient who was treated with red top pollen extract had no trouble with hay fever in Wyoming, and very little while he was in California. In some localities, alfalfa may be one cause of hay fever, since it produces pollen in abundance.

The majority of hay fever patients in New England begin their symptoms between the tenth and twentieth of August, the opening of the longest and most severe period of hay fever, which extends from the middle of August to the first frost. The chief cause of the late or fall hay fever is the pollen of the common ragweed (Ambrosia artemisaefolia), sometimes called the dwarf ragweed or Roman wormwood. The pollen is produced in enormous quantities and is so light and abundant that it rises in a yellow cloud when a pollinating plant is disturbed. The air at this season of the year, even in towns and cities, is laden with ragweed pollen, and the small, burr-shaped granules cling to other flowers, particularly golden rod and asters, to such an extent that these flowers which produce very little pollen of their own shed enough ragweed pollen when used for decorations indoors to cause symptoms in sensitive individuals. Many other compositæ such as golden rod,

golden glow, sunflower, aster, and cosmos, pollinate during August and September, but like other compositæ, particularly the dandelion in the spring and the daisy in early summer, these flowers produce very little pollen and are pollinated by insects, and consequently they can cause hay fever only by direct contact. Of a total of one hundred and twenty patients who were tested with the pollen of golden rod, 12.5 per cent. failed to react to whole pollen, 66 per cent. failed to react to a 1 : 100 dilution of the pollen, 10 per cent. did not react to a 1 : 500 dilution, 8.25 per cent. did react to a 1 : 500 but to no greater dilution, and only 3.25 per cent. reacted to a 1 : 1000 dilution, but to none higher. Therefore, in only 3.25 per cent. of the cases could golden rod be assumed to be a possible cause of fall hay fever. As in the case of daisy, the positive reactions to the pollens of compositæ other than ragweed in patients that give a positive reaction to dilutions of ragweed pollen are to be interpreted as an expression of botanical affinity between related plants rather than as an index of the cause of hay fever. Only in cases where the reaction to ragweed is negative or nearly so, is treatment with the pollens of other plants for fall hay fever indicated. One hundred patients were tested with sunflower pollen, and of these 50 per cent. reacted positively to the whole pollen, but gave no reaction with the 1 : 100 dilution of the pollen, and 50 per cent. failed to react to the whole pollen. Therefore pollens other than ragweed seem to play no important part in the cause of fall hay fever in New England.

In different seasons there is great variation with regard to the abundance of pollen, and the time of beginning and ending of pollination; the prevalence of colds during or at the end of the hay fever season may be interpreted as attacks of hay fever and so mask really satisfactory results of treatment. In 1918 ragweed began to pollinate about the eighth of August and heavy frosts stopped the pollination about the middle of September; consequently the hay fever season began early and was very short. In 1919 the weather was so cold and rainy through September that pollination was below normal in amount, pollen was kept so wet that it could not blow about, and colds were frequent; the amount of pollen present in the air was so small as compared with normal seasons that hay

fever symptoms were comparatively mild, and sometimes colds were mistaken for attacks of hay fever. In 1920 a hot, dry August was favorable for the development of ragweed, and since no hard frost occurred until late in October, pollination continued in profusion from about the thirteenth of August to the first of October when the plant naturally finished the production of pollen and went to seed; consequently the 1920 season was long and severe, with few colds, and in such a season the results of treatment are thoroughly tested. In the interpretation of results, particularly in comparing successive years, the seasonal variation and the condition of the patients, particularly with regard to the prevalence and susceptibility to colds, must be taken into consideration. In localities outside of New England, the ragweed is apt to be a common cause of fall hay fever, but the season of pollination varies in different places, and other plants that cause hay fever may be common. Another species of ragweed called the giant variety (Ambrosia trifida) is rare in the east central states and in New England, but in the middle west it is abundant and is a cause of hay fever that must be reckoned with in regions where it grows. In the far west sage brush and tumble weed may need to be considered also. Distant localities must be investigated by those who are familiar with the flora of the region.

Although the principal causes of hay fever in New England are the pollens of ragweed, timothy, and June grass, an occasional cause is the pollen of the rose, of red top grass, and of various trees. Since there is an almost unlimited supply of plants that may rarely cause hay fever, for testing the occasional patient who fails to obtain satisfactory results from treatment with the common pollens, an extensive assortment of the rare pollens is desirable. Patients who are sensitive to ragweed should be warned not to smell of golden rod, golden glow, sunflower, aster, chrysanthemum, and other plants that pollinate during the ragweed season. Patients who are sensitive to the grasses should avoid close contact with clover, daisy, lily, dandelion, rose, lawn grass, orchard grass, and corn, if there is evidence that they are sensitive to these flowers. One less obvious but frequent result of treatment with the pollen to which the patient is most sensitive is the freedom

with which the patient can go into the garden, walk in the fields, or smell of flowers that before treatment would have produced great aggravation of the hay fever symptoms. In other sections of the country it may be necessary to treat with the pollens of cereal grains, with sunflower, or other common plants.

The leaves of some plants and trees, or the fine hairs that make the pubescence on the under side of some leaves, may cause hay fever. One patient was studied who had hay fever from and was treated with the hairs of the leaf of the willow to which she gave a positive skin test, and symptoms were relieved after treatment with an extract of the leaves. Another patient of whom the writer has known was sensitive to and had hay fever from the plantain leaf. Although seasonal hay fever due to foods has not been noted by the writer, many hay fever patients find that their symptoms are aggravated by certain foods that they can eat at other times without symptoms when they do not have hay fever, and that these same foods do not cause hay fever during the usual hay fever season. if the patient has had sufficient preventive pollen treatment. These foods are usually the fruits, commonly the peach, melon, and apple, and they bear no relationship to the causative pollen. Frequently eating green corn and the use of wine and beer aggravate ragweed hay fever, but not hay fever from grasses, and sometimes celery acts in the same way. Usually it is the skin and not the flesh of the peach that produces symptoms, and cooking fruits renders them innocuous. Occasionally a patient with seasonal hay fever fails to react to any of the common or rare pollens, and in such non-sensitive cases even an ophthalmic test and snuffing whole pollen or spraying concentrated solutions of pollen up the nose fail to give symptoms. In such cases the primary cause seems to be bacterial infection, and treatment with autogenous vaccines made from the nasal secretions is often effective in relieving the symptoms. During hay fever seasons, some individuals who are sensitive to and have hay fever from pollens also have vasomotor symptoms ranging from sneezing to asthmatic attacks caused by odors from flowers that have no pollen or to the pollen of which the patient is not sensitive, particularly lilies, lilacs, hyacinth, sweet pea, honey-suckle, and

peony. Such olfactory stimulants may be classified as mechanical, chemical, thermal and odorific. Of the mechanical irritants, dust is the most common, particularly sweeping dust, hay dust, and street dust, and fine powders such as talcum. Soap powder, lye, and ammoniacal fumes are frequent chemical irritants. Of the odorific irritants, heavily scented perfumes, face powders, musty air, and stable dust are the most frequent. Thermal irritants are sudden changes of temperature, as going from warm air to extreme cold, from moist to very dry air, and exposure to draughts; a frequent example is sneezing with or without running of the nose on arising and retiring. Usually these symptoms are relieved by treatment with the pollen to which the patient is sensitive.

The causes of hay fever in New England have been discussed at length, with indications as to the pollen extracts that should be used in treatment. The history of the patient shows at what season the hay fever comes and hence the pollen that is the probable cause. The skin test to determine the specific pollen to which the patient is sensitive and with which he should be treated is made in the same manner as already described under Bronchial Asthma.

Having determined by skin tests which pollens give a positive reaction, before treatment can be instituted, it is necessary to know how sensitive the patient is to the pollen or pollens, and for this purpose skin tests are made in the usual way using different strengths of solutions of the pollens to which the patient reacts. These solutions are prepared as follows: To 0.5 gram of the dry pollen is added 44 c.c. of normal sterile saline and the mixture is shaken at frequent intervals for twenty-four hours; then enough absolute alcohol (6 c.c.) is added to the mixture to make the alcohol 12 per cent., and again the mixture is thoroughly shaken at frequent intervals for twenty-four hours; then the mixture is centrifugalized at high speed and the supernatant liquid is pipetted off and saved. This supernatant fluid which consists of the pollen protein dissolved in 12 per cent. alcoholic normal saline represents by weight one part pollen to one hundred parts solvent. This 1 : 100 solution is kept as stock, and from it other dilutions, 1 : 500, 1 : 1000, 1 : 5000, 1 : 10,000, are made by using a 12 per cent. alcoholic normal saline solution as a diluent. These solutions

are used for both skin tests and treatments, and with the ad-
dition of a small crystal of thymol they keep for months in a
cool place. Solutions of pollen suitable for tests and treatment
may be made by extracting the protein from the pollen, pre-
cipitating and drying, and using this pollen protein in the form
of a dry powder to make the pollen solutions by weight, or the
pollen solutions may be purchased from various drug houses,
all prepared for tests and treatment.

The principle is to test the patient with the identical solu-
tions which are to be used in the treatment. The strong solu-
tions will give a large reaction and the size of the reaction
diminishes in proportion to the decreasing amounts of protein
present in the higher dilutions, until the reaction becomes
doubtful and finally a dilution is reached which gives no re-
action on the skin. This dilution· to which the patient fails to
react is the dilution with which it is safe and proper to start
treatment.

From the experience of four seasons, a method of treatment
consisting of fourteen injections of pollen solutions, given
once a week in gradually increasing amounts, and terminating
just before the time of onset of symptoms, has been found
to give satisfactory relief in a majority of cases. This pre-
seasonal method of treatment with pollen extracts is as fol-
lows: The first dose consists of 0.1 to 0.2 c.c. of the strongest
dilution that failed to give any skin reaction whatever, no
matter how slight. The majority of patients gave a more or
less positive reaction with the 1 : 5,000 dilution, but frequently
were negative to the 1 : 10,000 dilution; therefore the first
treatment consisted of 0.1 or 0.2 c.c. of the 1 : 10,000 dilution.
Treatment was given subcutaneously once a week in gradually
increasing amounts, so that stronger and stronger dilutions
were used as the treatment progressed until one or more doses
of the 1 : 100 dilution were given. The best outline of treat-
ment for a patient who gives a more or less positive reaction
with a dilution of 1 : 5,000 of pollen extract is as follows:
1 : 10,000 give 0.15 c.c.; 1 : 5,000 give 0.15 c.c., 0.25 c.c., 0.35 c.c.,
0.45 c.c.; 1 : 1000 give 0.15 c.c., 0.25 c.c.; 1 : 500 give 0.15 c.c., 0.25
c.c., 0.35 c.c., 0.45 c.c.; 1 : 100 give 0.15 c.c., 0.25 c.c., 0.35 c.c.,
each dose to be injected preferably at weekly intervals and
never oftener than once in five days.

While the schedule of treatment calls for fourteen treatments, modifications frequently have to be used. Sometimes a patient is so sensitive as to give a slight reaction to a 1 : 10,000 dilution of the pollen and in that case an initial dose of 0.15 c.c. of 1 : 20,000 is given followed by one dose, 0.15 c.c., and sometimes a second dose, 0.25 c.c. of 1 : 10,000. Often it happens that a patient has considerable local or general reaction following some one inoculation in the schedule, making necessary the repetition of that particular dose before the next higher can be given. Often the patient comes for treatment too late to complete the scheduled series of inoculation before the onset of pollination, and for preseasonal treatment alone, some of the final treatment in the schedule must be omitted. In some cases the second treatment with the 1 : 1000 dilution, namely, 0.25 c.c., is omitted, and in some cases instead of giving 0.15 c.c. of the 1 : 100 dilution when this happens to be the final treatment that the patient can receive before the beginning of pollination, a fifth dose of the 1 : 500 dilution, namely, 0.55 c.c., is often substituted, and even a sixth treatment with the 1 : 500 dilution, namely, 0.65 c.c., is sometimes given. These larger doses of the 1 : 500 dilution approximate the amount of protein present in 0.15 c.c. and 0.2 c.c. of the 1 : 100 dilution; therefore, the fifth and sixth treatment with the 1 : 500 dilution is practically the equivalent of giving 0.15 c.c. and 0.2 c.c. of the 1 : 100 dilution. By far the greater number of patients are treated from three to five times with the 1 : 500 dilution and since this number of treatments has given fairly satisfactory results, this number of treatments, a total of ten seems to be worth giving, although a continuance of the schedule beyond three doses of the 1 : 500 dilution is desirable, and giving less than three treatments with the 1 : 500 dilution usually confers very little protection on the patient.

In order to complete the above schedule of fourteen treatments previous to the onset of pollination of the grasses and of the symptoms of early hay fever during late June, treatment with the grass pollens should begin about the first of March, and if treatment begins as late as the first of April, not more than the first three or four injections of the 1 : 500 dilution can be given. The importance of beginning preseasonal treatment with June grass not later than the first of

March and with timothy and red top by the middle of March at the latest is indicated by the results of varying amounts of treatment, for in general it has been found that the greater the amount of treatment, the more complete is the relief from hay fever symptoms. Of the seventy-eight patients treated pre-seasonally with grass pollens, thirty-six or 46 per cent. were free from symptoms, eleven or 14 per cent. were practically free, seventeen or 21 + per cent. were 75 per cent. relieved, eleven or 14 per cent. were 50 per cent. benefited, and three or 4 per cent. were not improved. The writer concludes from his experience that, although timothy pollen is the chief cause of early hay fever and sufficient treatment with timothy pollen extract alone gives excellent results, all patients should be tested with the pollens of June grass, red top, and rose, as well as timothy because an occasional patient who is more sensitive to one of these other pollens than to timothy, may need treatment with them rather than with timothy pollen. A patient who is equally sensitive to timothy and red top should be treated with timothy pollen extract alone because the two grasses pollinate at the same time, timothy is the more prevalent, and timothy pollen will protect against red top exposure, provided two or more treatments are given with the 1 : 100 dilution. Sufficient treatment with timothy pollen extract alone would also protect against June grass exposure, but since June grass usually pollinates comparatively early in the course of treatment with timothy pollen, before the larger and more effective doses have been given, the patient who is sensitive to June grass has more or less severe symptoms in late May and early June during the time of June grass pollination. Unless treatment with June grass pollen is started earlier than it is customary to start treatment with timothy pollen, not enough June grass pollen can be given before the time of June grass pollination to protect against June grass exposure. Treatment with a mixture of June grass and timothy pollen extracts retards and diminishes the amount of treatment that might be given with either one alone, because the patient more frequently has a sore arm, and has symptoms of hay fever in late May and early June that are really caused by exposure to June grass but may be considered as due to the treatment, with the result that doses of timothy pollen are repeated when

it would be safe to give the next increase in amount, thus cutting off some of the more important doses at the end of the schedule and causing incomplete protection against red top and timothy. Therefore preseasonal treatment with pollen mixtures seems advisable only in rare cases. It is possible to treat patients, who have symptoms in June and July and who are equally sensitive to June grass and timothy, by a combination of preseasonal or preventive treatment with timothy pollen extract alone, and curative or during the season treatment, with minute amounts of June grass pollen extract, given four or five times when the pollination of and symptoms from June grass first begin.

Frequently a patient presents himself for treatment after the symptoms have set in. Treatment of the patient with the pollen that causes his hay fever during the time he is exposed to the pollen present in the air he breathes, particularly treatment with large amounts of pollen, would seem on the basis of anaphylaxis to result in danger of an overdose of pollen due to the combination of the injected and the inhaled pollen, thereby increasing rather than relieving the hay fever symptoms. Nevertheless, although during the season or curative treatment is hazardous because there is no way of controlling the amount of pollen that is inhaled, this method of treatment is worth trying provided it is given with sufficient care and the skin test is used as a guide to the initial dose, as in the initial dose of preseasonal treatment. For instance, if the patient gives a positive reaction with the 1 : 10,000 dilution but fails to react to the 1 : 20,000 dilution, he is given of the 1 : 20,000 dilution of pollen extract a dose of 0.15 c.c., and five or seven days later 0.25 c.c.; then the 1 : 10,000 dilution, doses 0.15 c.c. and 0.25 c.c. Usually only four or five doses are given and the same five or seven day interval is observed as in the preseasonal treatment. Although a few patients are entirely relieved by during the season treatment and as many more as 75 per cent. benefited, many are only slightly relieved and nearly half of the number are hardly improved at all, so that it is a question whether this method of treatment is worth doing if the patient can go to a locality where his cause of hay fever does not exist. The results of during the season treatment are markedly poor in com-

parison with the results of preventive treatment. If during the season treatment is given with June grass pollen extract during late May and early June, after the patient has developed symptoms from June grass exposure, the treatment with timothy pollen is continued according to the schedule of preseasonal treatment, except that the June grass extract and the timothy pollen extract doses may be mixed in the syringe and given in one injection, provided each dose is measured with care.

Preseasonal treatment of fall or late hay fever follows the same schedule of dosage as that outlined for spring or early hay fever, with the exception that treatment with ragweed should begin late in April or early in May in order to complete the schedule of treatment with ragweed pollen between August tenth and twentieth, just previous to the shedding of ragweed pollen. Beginning ragweed treatment as late as the first week in June limits the treatment to from three to five injections of the 1 : 500 dilution. Of 439 patients treated preseasonally with ragweed, 25 per cent. were entirely free from symptoms, 20 per cent. were practically free, 32 per cent. were 75 per cent. benefited, 18 per cent. were 50 per cent. relieved, and 4½ per cent. were not improved. In the case of one patient who was not benefited, the skin test with ragwood was as strong after as before treatment and the last injection produced an anaphylactic shock manifested by urticaria, and in three other patients who gave positive skin tests with a 1 : 1000 dilution at the end of teatment in spite of the fact that they had received one or more doses of the 1 : 100 dilution, the apparent desensitization of the skin did not progress with the increasing amounts of treatment. It is probable that, for some unknown reason, the mucous membrane also was not desensitized or that there was lack of union between the patient's antibodies and the pollen treatment acting as an antigen. Two patients who were treated two and four times respectively with the 1 : 100 dilution failed to react at the end of treatment to all dilutions higher than the 1 : 100, and still were not benefited by the treatment. So that even with sufficient preseasonal treatment and apparent desensitization of the skin, as indicated by skin tests, there are a few hay fever patients who are not benefited by preseasonal pollentherapy. In two-fifths of the cases

the skin test at the end of treatment as compared to the skin test before treatment was decreased one hundred times, and in the remaining three-fifths of the cases, the skin test was diminished at least twenty times. In general, the larger the number of treatments given, the greater was the decrease in the sensitivity of the skin of the patient as indicated by the skin test, and the more nearly complete was the relief from symptoms. Further evidence of the more complete relief derived from larger amounts of treatment is shown in patients who are treated several years in succession. Usually a patient who is more or less benefited one year by insufficient treatment is completely relieved by sufficient treatment in another year. Favorable results follow any number of successive years' treatment, provided the average number of treatments is given each year. No matter how many successive years the patient is treated, approximately the same amount of treatment with the final dilution of the pollen extract is required as in preceding years, but no greater amount is necessary in succeeding years.

Still another method of treatment, which has been used with success by various investigators, is particularly adapted to patients who apply for treatment some time before the onset of their symptoms, but too late to complete the full schedule of preseasonal treatment. The initial doses of preseasonal treatment are given as usual, but instead of stopping all treatment when pollination and symptoms begin, the increasing doses are continued according to the schedule right through the hay fever season. The results of this method of treatment, while not so good as those from sufficient preseasonal treatment, are more satisfactory than the results of during the season treatment alone, in that while few patients were entirely free from symptoms, one-third of the cases were 75 per cent. benefited, and nearly one-half of the cases were 50 per cent. improved, and only one-tenth of the cases received no benefit. It would seem fair to say that this method of treatment is preferable to during the season treatment alone, but not as effective as the regular preseasonal treatment, which is begun early enough to permit its termination just before the onset of pollination.

Multiple sensitization to pollens, as has already been indicated, is a fairly common phenomenon, and frequently patients

who have hay fever nearly all summer, except for a slight pause during the first two weeks in August, are sensitive to the grass pollens and also to ragweed. The best treatment for these patients who have both early and late hay fever is to start with timothy pollen extract alone, if timothy is the proper pollen with which to treat the early hay fever, at the customary time in March, and follow the schedule of increasing doses until the customary time to begin treatment with ragweed pollen extract late in April. The ragweed treatment for fall hay fever is then instituted and carried on independently of the timothy pollen extract treatment, except that the two pollens are given together in the same injection until just before the onset of timothy pollination. At that time the timothy pollen is stopped entirely and the ragweed continued alone up to the usual time for completing it, just previous to the pollination of ragweed. This method of treatment with mixed pollens is less satisfactory than treatment with either pollen alone, because to some extent each diminishes and retards the effect of the other pollen, doses have to be repeated more frequently, and it is difficult or impossible to give during the season treatment with June grass pollen, even though the need of treatment with June grass pollen is indicated by the symptoms and sensitivity of the patient.

The time of stopping preseasonal treatment varies somewhat with the earliness or lateness of the seasons of pollination, the variations of which from year to year have already been described. When the pollen develops earlier than usual, it may be necessary to stop treatment before the last few doses have been given, for fear of symptoms from an overdose when the pollen is inhaled. Correspondingly, when the season of pollination is delayed, it is sometimes desirable to give another dose or two after the usual time of terminating the treatment, because the pollen is not yet present in the air. In localities outside of New England the seasons of pollination differ and the time of pollen may vary also. If treatment is given for the tree pollens in early spring, it should start in January or February.

When patients have seasonal hay fever primarily from bacterial infection, relief of the symptoms is secured in a number of cases by treatment during the season with autogenous vaccines made from the nasal secretion; this comparatively

rare type of non-sensitive seasonal case has been described on a preceding page. In patients who are sensitive to and treated preseasonally with the appropriate pollens, bacterial infection of the irritated mucous membrane may be a secondary cause of symptoms during the season, and perhaps even more frequently the symptoms are continued by bacterial infection long after the termination of the time of pollination. Treatment with autogenous vaccines made from the nasal secretions after the onset of symptoms, or sometimes even treatment with stock vaccines of streptococci or Staphylococcus pyogenes aureus or albus, may give relief.

Perennial Hay Fever. Patients who complain of hay fever symptoms throughout the year should be tested and treated as already outlined under Bronchial Asthma. Routine tests should be done with the food, animal hair, feather and pollen proteins and proper treatment instituted. If the patients are non-sensitive, autogenous vaccine made from nasal secretions are worth trying.

CHRONIC FIBRINOUS BRONCHITIS.

Since cases of chronic fibrinous bronchitis have been so frequently reported in the literature it is considered as an unusual condition. If, however, a more careful macroscopic examination of the sputum of patients with bronchitis, asthmatic bronchitis and the like was made, the condition would be much more frequently encountered.

Cases of fibrinous bronchitis fall naturally into three groups, namely, acute bronchitis with expectoration of branching casts, chronic bronchitis with expectoration of branching casts and cases in which branching casts were not expectorated but were found in the bronchi at autopsy. Since the chief distinction between the acute and the chronic form is the duration of the disease or the repetition of attacks in the latter, and since most acute cases become chronic because death or permanent relief rarely follows one attack, and since the symptomatology is the same in both types, only the chronic type of fibrinous bronchitis will be discussed.

Branching casts may be found in the sputum of diseases other than fibrinous bronchitis. Occasionally in organic heart

disease, in pulmonary tuberculosis, in pneumonia and frequently in cases secondary to diphtheritic inflammation of the larynx, branching casts are expectorated. Furthermore, it is not uncommon to find small casts without branchings in the sputum of asthmatic bronchitis, and rarely these are found in association with pulmonary edema and lobar pneumonia. None of these conditions, however, are considered to be fibrinous bronchitis, since the formation of casts is secondary or related to some other condition. In other words fibrinous bronchitis is idiopathic, whereas in the conditions just mentioned above the formation of casts is symptomatic.

A brief analysis of the symptomatology as usually obtained from casts of fibrinous bronchitis is as follows: The usual age of onset is between the ages of thirty and sixty, with a progressive increase of incidence up to middle life and then a gradual decline. Occupation, family history and chemical irritants seem to have little or no bearing whatever on the disease.

Often there is a previous history of some acute infectious disease, and almost invariably there is a past history of chronic bronchitis. The onset of chronic fibrinous bronchitis is usually with an exacerbation of a chronic catarrhal condition; there may be some fever. In the acute cases there is usually a preceding acute bronchitis, accompanied by considerable elevation of temperature and frequent chills. In both the acute and chronic forms there are paroxysmal attacks of dyspnea and some cough, and these generally immediately precede the expectoration of casts. The dyspnea is chiefly inspiratory in type, the cough is very hard and there is considerable cyanosis and frequently a feeling of tightness or constriction in the chest. Symptoms are temporarily relieved by the expectoration of casts, and the severity of the symptoms are greatly out of proportion to the size or number of casts which, when raised, relieve the attack. Between the raising of large casts, small and incomplete portions of casts are usually expectorated. The amount of respiratory distress would seem to be out of proportion to the degree of limited obstruction caused by the small incomplete casts unless there is a reflex obstruction involving a larger area of the bronchial tree. Hemoptysis is rare. There may be considerable loss of weight and strength.

Physical signs do not distinguish fibrinous bronchitis from ordinary bronchitis, with the exception that when the casts are *in situ* a very coarse, dry, clicking sound, probably caused by the flapping to and fro of loosened portions of casts, may be heard with both inspiration and expiration. Impairment of resonance may be elicited and all types of râles may be heard. One would expect impairment or absence of breath and voice sounds in the area of lung that is obstructed, but this is rarely the case, probably because there is not total obstruction by the casts, which usually have a lumen.

For a detailed description of the casts references should be made to Bettmann's paper.[18] In general the large casts average 10 centimeters in length and show branchings to the seventh degree. They are white in color and have a consistency of fibrin, Many branches have little intumescentia, which may be due to air bubbles or to diverticuli. A lumen may extend throughout the branches, but often the terminal branches end either as a solid plug or as a Curschmann's spiral. Usually small portions of casts are expectorated for some time after a large cast has been expelled. Microscopically the casts usually present a fibrillar, stratified ground substance containing in its meshes leukocytes. The amount of fibrin varies and there is not as much present as one would anticipate. In each case reported only one or two distinct tpes of bacteria have been found, so that each author has considered that the bacteria found in his particular case were the cause of the condition. On reviewing the literature, however, the bacteria found in the different cases vary so widely that one must conclude either that any type of organism may cause the condition or that the organisms present in the casts bear no relation to the cause of the disease.

There seem to be no definite sequelæ or complications in this disease, and only rarely is there a fatal termination as a direct result.

Discussion of the Etiology of Fibrinous Bronchitis. The etiology of this disease is obscure. In a few cases at post mortem there was a break in the continuity of the bronchial epithelium, in others the bronchial epithelium has contained a large number of mucus-secreting cells which would suggest an exaggerated secretion from the normal mucus glands. The

fact that the casts are composed in greater part of mucus would substantiate the increased secretion of mucus and the small amount of fibrin in the casts might come from the rupture or break in the bronchial epithelium. Retention of this mucus and fibrin in the bronchial tree for some time would permit of coagulation or hardening of these substances so that a cast is formed. There would be some irritation causing the accumulation of leukocytes, and since bacteria are normally present in the bronchi, leukocytes and bacteria would naturally be present in the casts.

Since in some cases of fibrinous bronchitis there is an element of neurosis, this condition has been considered by some as allied to mucous colitis. These two conditions are similar in that the intestinal casts of mucous colitis resemble closely the bronchial casts of fibrinous bronchitis, and the etiology of both conditions is obscure.

The author prefers to correlate fibrinous bronchitis with asthmatic bronchitis, bronchiectasis and chronic bronchitis. In almost all of the cases of fibrinous bronchitis, asthmatic bronchitis and bronchiectasis there is a preceding history of bronchitis, and throughout the course of these diseases there is a background of bronchitis. When patients with bronchitis develop paroxysms of dyspnea and suffocation the condition is then called asthma ; in order to distinguish this condition from true bronchial asthma the author calls this condition asthmatic bronchitis. For the author's differentiation between true bronchial asthma and atypical or asthmatic bronchitis one may refer to Differential Diagnosis, under Bronchial Asthma (page 852).

If in cases of bronchitis, breaks in the bronchial epithelium, with more or less loss of it occur, fibrinous bronchitis may result; if these breaks invade the deeper structures of the bronchial tubes, thereby causing a weakening of the structure, bronchiectasis may result. In asthmatic bronchitis there is a simple catarrhal desquamation of the bronchial mucous membranes much in excess of that which occurs in bronchitis, and in fibrinous bronchitis there is a permanent loss of the epithelium. Furthermore, in asthmatic bronchitis it is not uncommon to find non-branching casts and plugs in the sputum. Very likely all of these conditions are caused by bacteria, and

we know that a large proportion of the cases of bronchitis and asthmatic bronchitis are due to bacteria, since autogenous sputum vaccines frequently relieve the condition; in fibrinous bronchitis and bronchiectasis, however, vaccines do not benefit, because too much destruction of tissue has taken place. Local lack of vitality probably explains why bacteria produce these conditions in some individuals. Because of the local lack of vitality or inadequate resistance of the bronchi to infection in some persons, bacteria, which in others are non-pathogenic, are able to set up infectious processes. Flurin speaks of the "syndrome. de débilité bronchique," which is characterized by hyperesthesia of the mucosa, unstable local circulation and special secretory response to any causes liable to stimulate secretion in the mucous glands.

Treatment. The treatment of chronic fibrinous bronchitis should consist chiefly of rest, fresh air and forced feeding. Small doses of potassium iodide seem to help in the raising of the casts and naturally this diminishes the amount of cough and dyspnea. The very acute attacks are temporarily relieved by adrenalin chloride 1:1000 (Parke Davis and Co.) in 8 minim doses subcutaneously. In that autogenous sputum vaccines seem to benefit they are well worth trying.

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Diseases of the Ear, Nose, and Throat

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Diseases of the Ear, Nose, and Throat.

FOREWORD.

In a volume of this nature, it is impossible to go into too great detail of the various affections of the nose, throat, and ear, which are particularly apt to occur between the ages of twenty and fifty years. However, a general résumé of these conditions, touching mainly upon those that are of the greatest importance, will give one an idea of those that can be most readily avoided, and the proper care that should be taken in each instance. As in conditions in other stages of life, the diseases of the nose, throat, and ear occurring at this time, divide themselves into the acute, the subacute and the chronic. By far the majority of the acute conditions are those which may occur at any time, either before the twentieth year of age or later, after the fiftieth year. Among them may be mentioned particularly, acute sinusitis of nasal origin and acute mastoiditis. There is nothing especially significant of these diseases when they occur in middle life. The power of the individual to resist the disease will depend upon the general physical stamina which he has at this time, the same as in other ages of life. Among the more subacute conditions may be mentioned the various catarrhs, which are more likely to occur in the larger cities; among the chronic conditions, one may refer particularly to those ear diseases which eventually resolve themselves into what is termed progressive deafness.

There are many factors which enter into the appearance of certain diseases at this time. One must not fail to consider the various *hereditary influences* which play a considerable part, particularly the transmission of weaknesses in the mucosa of the nose, throat and ear, and also the various malformations which occur as the result of a familial type. One can hardly speak of hereditary transmission of diseases

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of the nose, throat, and ear, yet it is particularly important that special care be taken of these membranes in individuals whose families have shown a tendency towards an irritation of these parts. Although heredity may be ruled out entirely in many instances, there are certain factors in childhood which must certainly be taken into account. If one were to divide the nose, throat, and ear into separate organs which have no association, one would be inclined to feel that the *diseases of childhood,* either the exanthematous diseases or the various inflammatory conditions which irritate the nose, throat and ear, are accountable for many of the chronic irritations which occur later on in life, and so one may say that the preventive treatment of these conditions is a factor which is emphatically to be reckoned with. An example of this kind may be found in those cases of progressive deafness which occur during the middle years of life, and are not very noticeable until after the twentieth year, because their origin is an acute inflammatory condition of the ear, occurring in conjunction with a scarlet fever or measles in childhood. At the time that the acute exanthematous condition is present, very little attention is paid to the ears, unless some suppurative process takes place. For that reason, after the child gets well, nothing is done to prove that the hearing is as good as it was before the disease had occurred. If the ears had been examined properly at such a time, there is no doubt that something would have been done to restore the hearing to as nearly a normal condition as possible. However, an insidious process has arisen which, although it could have been overcome in the beginning, goes on, until a large part of the hearing is destroyed, without the child being aware of the fact. And, perhaps, as this occurs more often than one realizes, no disturbance of hearing is observed. The patient makes little complaint, until he has reached middle life, and then it is impossible to alleviate all the harm which has been done in the intervening years.

Among the gravest of the factors which tend to give a great deal of trouble with the nose, throat or ear, in middle life, are those which *devitalize the general physical condition* of the patient. It must be understood plainly, that the nose, throat, and ear are an integral and definite part of the body system,

and that when any diseased condition occurs there, it is
associated with some general physical debility.   Now, this
may not mean that a disease has been particularly noticeable,
but it is an absolute fact, which has been proved many times,
that diseases of the nose, throat or ear, especially those of
a subacute or chronic process, do not occur or are eliminated
very rapidly, if the patient's physical condition is up to par.
A number of years ago, a well-known nose and throat spe-
cialist of New York City, had been suffering from frequent
colds in the head, and after trying every one of his own
remedies, he came to the conclusion that the reason why he
was suffering from this trouble was because he did not have
proper elimination of the various toxins in his body.   He
therefore made up his mind to go through a systematic
course of exercise every day, until the exercises resulted in
a profuse sweat.   The result of this was that the membranes
of his nose and throat became normal within a few days.
As long as he continued with this form of treatment, he had
no trouble with his nose, throat or ear.   In other words, the
lowered resistance of the tissues was due almost entirely to
the lowering of his general vitality.   Numerous examples of
this kind can be recalled by everyone, and it is not uncom-
mon for the specialist, treating these diseases, to advise his
patient to go into a different climate and relax entirely,
whereupon all the troubles with which the patient has been
suffering, disappear within a very short time.   Among the
factors which lower the vitality of the individual, sufficient
to make the mucous membranes of these parts particularly
susceptible, are overwork, worry, strain (particularly mental
strain), the frequent changing of atmosphere, such as going
from a steam-heated apartment into the cold air, the lack
of proper exercise, the improper attention to the bowels with
stagnation of fecal matter in the intestines, and the general
sedentary way in which most people live in large cities.   One
frequently has patients coming in to him who make the
remark that during the summer they are entirely free from
their colds and infections of the nose, throat and ear, while
they immediately begin to get these infections again, as soon
as they go into the city after a long rest in the country.
There could be no better evidence of the reaction of the

mucous membranes of the nose to proper rest and the change of climate. It is not only that the summer atmosphere is more conducive to a cleaner condition of the mucous membranes, but that the patient leads more of an out-door and active existence.

Habits, of course, have a great deal to do with the setting up of irritations of these membranes, and among the worst of these are the continual intake of alcohol, and excessive smoking. However, too much stress has been laid upon these two factors. At the present time, with prohibition in vogue (except to those individuals who are unfortunate enough to get adulterated alcohol from unconscientious boot-leggers), one can almost eliminate the alcohol factor as a causative agent. Although smoking will irritate the mucous membranes considerably, it is surprising how much irritation of this kind these membranes can stand without being seriously affected. Many times, the individual who suffers from an irritated and congestive condition of the nasal and throat mucous membranes through the winter, when smoking excessively, will not be troubled by any thing of the same kind during the summer, although he may smoke more at this time than he did during the colder months. Aside from this fact, however, is the observation which is frequently made, that patients who come in for consultation, having what might be called a "smoker's throat," never have tasted tobacco. In other words, there is actually no such thing as a "smoker's throat." It merely means that the throat becomes irritated in such a way as to produce a clinical picture commonly given this name.

Occupation has a great deal to do with the inflammatory condition of these parts, particularly of the subacute and the chronic types. Patients who are working in a dusty atmosphere, who are constantly inhaling dust and smoke from suburban trains, for example, or who are working in places where there are irritating chemical fumes, such as in a chemical factory, are bound to have irritated conditions set up in the nose, throat or ear, which may result in serious injury. However, there are other types of workers—men who work in excessive noises, such as riveters or boiler-makers—who, on account of the constant impact and vibra-

tion of the instruments they are working with, set up an irritative condition in the ear which sooner or later results in deafness. The same condition may also arise in caisson workers, who have to do a great deal of work in tunnels, where the pressure of the air has a direct effect on the ear; but in the majority of cases, occupation plays very little part, except insofar as it lowers the resistance of the individual or exerts a direct local action. A sedentary existence with inside work, day in and day out through the year, and on days of rest, such as Sundays, with no offset to this routine of work by going out into the country and inhaling some fresh air, will predispose to upper respiratory affections.

When one comes to analyze the acute conditions of these parts which arise in middle life, he is wont to feel that a great deal will depend upon the *type of infecting organism* which is present in the air during the course of a certain season. We all are aware of the inroads of epidemics of influenza and "Spanish Flu" within the past decade, and when such infections occur, one must of necessity realize that certain acute conditions of the nose, throat and ear, are going to take place which must be immediately overcome. Aside from this, it seems that organisms have a peculiar faculty of changing their virulence from year to year, and although a certain type of streptococcus may not be particularly virulent in one year, so that infection resulting from them may be very mild, in other years the same organisms may become so virulent that the results are extremely serious. In the year 1920, for example, the *Streptococcus hemolyticus* obtained a peculiar virulence, with the result that almost every patient who had an acute process of the nose, throat or ear caused by this organism, went through a stormy time, with severe infections either of the nasal sinuses, or of the ear, often resulting in operative procedures. One can never tell when such conditions will arise, and will have to watch the virulency of the organism, and his judgment will vary according to the symptoms which present themselves.

It is not unreasonable, at this time, to comment upon the usual attention that is paid either by the patient himself, or by the general practitioner, to conditions of the nose, throat or ear which result in what are seemingly *catarrhal*

processes. The word "catarrhal" is a large, broad term which means absolutely nothing. It is simply that every inflammation of the nose, throat or ear, which is not of an extremely acute nature, resulting in fever, or severe pain, is called catarrhal. The term is used as indefinitely as the term neuralgia used to be. And to attempt to treat a so-called catarrhal process by any of the numerous remedies which have been in vogue for years, and which are almost considered household remedies by the patient and physician, does not clear the situation. Those patients should be given the benefit of a thorough physical examination, in order to determine the etiological factors present. One cannot help feeling that frequently prevention would result in cure. In other words, if the cause of the trouble were found in the first place and eliminated, half the battle would have been won. Of course, one realizes only too well that the general tendency is for the majority of the nose, throat, and ear specialists to be operatively inclined, with the result that many patients fear that if they consult a specialist in these lines, it will be necessary for them to undergo some operation which may or may not be necessary. However, that is not the point to be considered. What one should consider is that there is always something in the general physical condition, or the local condition of the patient, which is causing an irritation of these mucous membranes and this something must be found out if the physician wishes to do the best for his patient. For example, I have seen patients who are repeatedly treating themselves on the advice of their family physicians, by dropping argyrol into the nose, or by douching the nose with a glass nasal douche which may cause a great deal of harm to the ears, or by using an atomizer which reaches no further than the anterior nares. These patients do themselves little good, except mentally, and in many instances a chronic irritative process is set up, simply because there has been definite neglect which could have been avoided if a proper suggestion as to treatment had been given in the beginning. This applies particularly to those insidious ear conditions which result in deafness in adult life. There is no condition of which we know, which is more fearful to the patient than a deafness which interferes with him, so-

cially, and economically—a deafness which might have been prevented. Sometimes, nine-tenths of the hearing is lost before one becomes aware of the fact and then, often, it is too late to do anything. Yet, however, if the patient had taken the warning tinnitus which frequently comes before the deafness is noticeable, and had consulted a specialist who was able to thoroughly examine him, so as to determine the exact causative factor, there is no doubt that a great deal might have been done, either to have kept the hearing from becoming worse or to have improved it. Such· neglect is often the fault of the physician, who, on being told by the patient that the ears feel a little stuffy or that they are not hearing quite so well, informs him that it is something he should expect; or he may say that if he goes to a specialist, he will hear no better than before and perhaps far worse. I admit that a great deal of mistreatment has been given, but nevertheless, with our more exact knowledge of these parts, mainly because of the universal employment of electrically lighted instruments, there is no reason why the proper intelligence should not be used, so that one may arrive at a very definite and accurate conclusion as to what the actual cause of the trouble is, and determine whether it will be possible to remove the cause, or at least to arrest the condition, so that it cannot progress to the stage where it may become an absolute menace to the happiness of the individual.

In general, *the care of the nose, throat, and ear,* in adult life, resolves itself into the proper building up of the patient's physical condition and the local treatment of the mucous membranes of these parts. Much can be done in building up the general physical condition, by proper diet, proper exercise and proper elimination of waste products. It is not within the province of this section to indicate any further what the exact general treatment should be. However, when it comes to local treatment, one can feel that the proper cleansing of the mucous membranes of the nose and throat is of the utmost importance when it is done properly. A great many people are in the habit of snuffing up water (salt water preferably) as regularly each morning as cleaning their teeth, and think that they have cleansed the mucous membranes sufficiently to keep them in good condition. There

is no more erroneous idea than this. In the majority of cases, the water reaches only as far as the anterior nares and never goes further. Gargles sometimes do a great deal of good by keeping the mucosa of the throat and pharynx in fairly good condition, but the solution which is used in an atomizer very seldom does more than coat the outer surfaces of the mucous membranes in the anterior nares. The patient should be given definite instructions. For example, douching should be performed in a manner which will do the least harm and by employing a solution which will cause the least irritation. Preference is usually given to some form of syringe, similar to a fountain syringe, where there can be free flow of solution. Nothing is better than a hot saline solution for douching. However, the great mistake the majority of people make is that they cleanse these mucous membranes too thoroughly, with the result that as soon as they are again exposed to the air, further irritation takes place.

In all instances where the mucous membranes of the nose and throat are cleansed by douching, this should be followed by the spraying of the nose with some mentholated oil, or mentholated oil should be dropped into the nose and nasopharynx with a medicine dropper. The application of strong medicaments to the nose or throat should not be undertaken by the patient under any circumstances, except on the advice of the physician. The direct application of argyrol to definite parts, for example, is more than worth while and sometimes irritation in the nasopharynx may be overcome with this medicine, but the usual manner of its employment by dropping it on an inflamed mucous membrane, seldom does much good. Argyrol is not an antiseptic, but apparently has the aseptic property of overcoming the further growth of bacteria, and for this reason is of value when applied to a localized area. The same objection may be made to the use of various other medicines in the nose and throat, but argyrol has attained such popularity that it seems not out of place to mention this fact here. The simple cleansing of the mucous membranes with a hot saline solution, followed by an oil, frequently will do far more good than the application of stronger medicaments, unless the

membranes are properly shrunk up by the physician and the applications of medicine made directly.

After this short consideration of general conditions, we shall now devote our attention to those particular diseases which are prevalent during middle life.

DISEASES OF THE EAR.

ACUTE CONDITIONS.

Among the acute ear conditions with which one has to deal during middle life are, furunculosis of the ear canal, myringitis, acute suppuration of the middle ear, and acute mastoiditis with its complications. It is impossible to go into technical details of these conditions in a short article like this, but consideration will be given to the essential features of each one, and the differentiation between them.

Acute Furunculosis.

Acute furunculosis occurs mainly from irritation in the ear canal and resultant infection. Often this occurs as a result of a continual picking at the ear with some foreign body, such as a tooth pick, match, or the ordinary ear spoon. Such practices should be condemned at all times, because a direct injury is caused to the canal wall and the cerumenous glands, and an infection will readily take place. Furuncles are extremely painful and may result in some serious complication, such as an infection of the glands of the neck. The tension on the canal is extreme and any touching of the ear, either in front or in back, or any palpation over the mastoid bone, will be exceedingly painful. As a rule the canal becomes very much narrowed or may close entirely. If the furuncle occurs in the external portion of the canal, very little diagnostic acumen is necessary to recognize it. However, there are sometimes deep-seated furuncles which are associated with suppurative conditions of the middle ear and in which it is difficult to decide which is the more acute process and which needs the more attention.

In many cases furuncles can be *treated* by topical application, particularly during the so-called ripening stage, where no definite pointing is present. At the onset of the condition,

the patient should apply a hot-water bag to the side of the head, and should be instructed to irrigate the ear canal with a hot saline solution. Immediately some attempt must be made to reduce the inflammation in the canal. This may be done by introducing a small strip of gauze, saturated with glycerin into the canal. Sometimes a combination of two per cent. iodin in glycerin works better than the plain glycerin alone. At other times, the canal may be packed with a piece of gauze, saturated in a four per cent. aluminum acetate solution or in a lead and opium wash. This piece of gauze should be kept continually moistened throughout the day. On the following day the gauze should be removed and inspection again made of the canal. If more swelling has taken place and definite localization has occurred, it may be necessary to incise the furuncle and an attempt made to evacuate whatever pus is present. Incisions of furuncles usually have to be made very deep and oftentimes there is such profuse bleeding at the time of the operation, that it is impossible to see whether any pus comes away at all. The opening of the furuncle must invariably be performed under general anesthesia, such as ethyl chloride or nitrous oxide gas, and as soon as the deep incision is made, a packing should be inserted into the opening so that it will not close within the next twenty-four hours. If one sees pus, he may rest content that the condition will resolve within a very short time. On the contrary, if he does not see any pus, it may be necessary for the edema of the tissues to subside until the deeper portion of the abscess evacuates itself. It is surprising, in many of these cases, to see how deep-seated these abscesses are, how small the abscess itself is, and how much of an area of infiltration there is around it.

Acute Myringitis.

Acute myringitis is a term used to denote an inflammatory condition of the drum membrane without any suppurative process behind it. It occurs mainly after bathing or traumatism to the drum, or after an acute infection which resolves without suppuration. It is important to recognize such a condition because the inflammatory reaction that occurs will often be so positive as to make one wonder whether it is

not necessary to incise the drum. In the majority of cases, such a condition of the drum subsides without incision. The differentiation between it and an acute suppurative process may be made by noting whether there is an inflammatory condition with bulging or without bulging. In the former, the drum outlines are maintained in every particular with the exception, possibly, of a loss of the light reflex. The drum is either pink in color, or a very deep red, and sometimes there is an exfoliation of the superficial epithelium so that the drum is covered by a dry membrane. This must be wiped off before the actual condition of the drum can be seen.

The pain associated with acute myringitis is often extreme. There is seldom high temperature in adults, although in children the temperature may rise as high as 104° and 105° F. When the condition first presents itself, in most cases the patient has an excruciating, sharp twinge in the ear, which becomes aggravated as time goes on. However, the writer has often seen cases where an inflammatory condition of the drum has taken place without any indication of such a condition, except the diminution in hearing. So one may consider that the two vital symptoms of acute myringitis are the extreme pain, on the one hand, and the loss of hearing, with possible tinnitus, on the other.

The patient almost at once is willing to consult a physician, either because of the acute pain or because of the defect in hearing. The physician, on examination of the drum, will see the evidences present, as explained above. Conservative and expectant *treatment* is more than worth while. In the majority of instances, if one will allow the patient to be absolutely quiet for a few days, giving proper systematic treatment, the condition of the drum will resolve, unless it is associated with an infectious condition in the nasopharynx, with an acute cold in the head, or a sinusitis. The patient should be instructed to syringe the ear out at regular two-hour or three-hour intervals, with hot saline solution, from a fountain syringe, and should apply a hot bag to the ear. The rest of the treatment is entirely symptomatic. Five grains of aspirin, to which is added one-quarter of a grain of codein, taken every four hours, is sufficient to allay the

pain. It is always advisable to keep the patient under observation until the hearing has returned to normal. Attention should be paid to the general physical condition of the patient, because under such circumstances the resistance in the middle ear may be lowered so that there is always a possibility that an infection of this small cavity may take place.

Acute Suppurative Otitis Media.

Acute suppurative otitis media is invariably an aftermath of some infectious condition of the nose and throat, such as tonsillitis, an acute sinusitis or acute coryza. The patient, having had an inflamed and infected condition of the mucous membranes of the nose and throat, has a lowered vitality in these membranes, and the infectious matter readily creeps up the Eustachian tube into the ear. Oftentimes, such infections are thrown into the ear by forcible blowing of the nose. At once the patient is aware of an acute inflammatory process taking place there, because of the excruciating pain that immediately results. It does not take long for the inflammation to spread around this small cavity and an infection result. On account of the bacteria which are present, even when there is only a serous process, pus forms within a few days. This may be particularly noted in cases in which an incision of the drum membrane has been made. At the first examination of the ear, one may only see an acute inflammatory reaction, similar to that seen in simple myringitis, but within the course of a few hours, distinct bulging of the drum takes place. The author has seen one case in which the suppuration took place so quickly that he was able to observe the bulging of the drum during the examination of the ear. The patient eventually developed an acute, operative mastoiditis. Sometimes the infection takes place so quickly that, within an hour or two, an incision has to be made to relieve the pain. Temperature is not uncommon. It should be watched carefully. As a rule, the patient complains of general malaise and headache.

The patient should be put to bed and allowed to undergo either an expectant *treatment* for a day or so, or have an incision in the drum made at once. A properly performed

paracentesis is the most important procedure possible, under the circumstances, and is far better than expectant treatment, whenever enough bulging takes place to indicate that there must be an immediate evacuation of the contents of the middle ear. If this is not done there may be a possible spreading of the suppuration through the mastoid cells. In fortunate cases, a spontaneous perforation occurs, which allows of sufficient drainage. Where the tension on the drum is not severe, one may be able to abort the infection by dropping a solution of adrenalin and Dobell's solution into the nose so that it reaches the nasopharynx and the Eustachian tube, thus opening up the tube and possibly evacuating the exudation within the middle ear in this way. This happens but rarely, but should be tried.

A properly performed *paracentesis* should almost invariably be performed under a general anesthetic. Sometimes it is possible to anesthetize the ear canal and the drum by making applications of a solution of equal parts of cocain, menthol and pure carbolic acid. The author has seen a number of patients who were not acutely sensitive, who would allow a drum to be opened up under local anesthesia, and who claimed that the procedure was painless. However, in most cases, a general anesthetic must be given, either ethyl chloride, or nitrous oxide gas, alone or associated with oxygen. A paracentesis is a very simple procedure when performed properly, but it is absolutely necessary that more than a stab be made. The incision should extend from the upper posterior portion of the drum, along the circumference, down into the anteroinferior quadrant. This will circumscribe about two-thirds of the drum membrane. Many incisions do not stay open for a sufficient length of time and there is always a tendency for the edges of the incision to glue together, so that only a small, pin-point perforation remains. At the time of the incision, a culture from the discharge should be made, upon a sterile swab, and sent to the laboratory, because it is most important that one determine what the exact organism is which is causing the infection. Certain organisms, such as a staphylococcus, are not extremely virulent, and thus one may temporize and use conservative treatment. On the contrary, if the infection is

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caused by the *Streptococcus mucosus capsulatus,* for example,
one should be aware that the infection will spread to the
mastoid cavity within a short time, and that very possibly
a mastoidectomy will have to be performed, to clear up the
condition.

When a paracentesis is performed, there is often a profuse
discharge of blood, with the discharge of pus, from the mid-
dle ear. No account should be taken of this, as the hemor-
rhage may be controlled by placing small pieces of cotton
into the canal. During the first few hours, it is unnecessary
to syringe the ear, but after this time, when actual pus ap-
pears, the ear should be regularly syringed every two to
three hours, with hot saline or boric acid solution, and a
hot-water bag should be applied to the outer ear. The pain,
immediately after the incision, is usually quite severe, but
will subside within a short time. The patient may be given
a dose of morphin—a quarter of a grain, either by hypo-
dermatic injection or by mouth. As a rule, within a few
hours after the incision, the patient feels far more comfort-
able. The ear should be examined the following day, after
thorough cleansing. In the majority of cases, one will find
that the edges of the incision have glued together and that
only a small pin-point opening remains at the lower, posterior
angle of the wound. The edges of the incision may be pulsat-
ing, due to the pressure of the secretion which is behind.
If the edges of the incision seem to be glued together, they
can easily be separated by applying suction through an elec-
tric otoscope. This simple procedure will often make a
second or a third paracentesis unnecessary. After the drum
is opened, one may feel convinced that there is a spread of
the inflammation through the mastoid cells, as there is often
extreme tenderness noticed, and the patient will be aware
of a full feeling on this side of his head. A careful record
of the temperature should be kept and one should watch for
further mastoid invasion.

In the majority of cases, in which there is an acute tender-
ness over the mastoid, one need not be unnecessarily alarmed,
if this tenderness persists only for a day or so and gradually
retrogresses. On the contrary, if the tenderness seems to
persist, or seems to spread backward or toward the tip of

the mastoid, there is always the possibility that some cells are infected which are unable to drain themselves through the opening in the ear drum. Yet, one should never come to the conclusion that, merely because the patient has mastoid tenderness, associated with an acute suppuration of the middle ear, it is necessary to consider that the patient has an acute mastoiditis which warrants surgical intervention. It is surprising to see how many cases there are where such tenderness persists for some length of time, with moderate temperature, and gradually disappears without giving any further trouble. The author recalls one family in which four patients had an acute suppuration from the middle ear, with high temperatures, with an organism of exceeding virulence, and yet only one of these cases had the mastoid bone operated upon, in order to clear out the infection. All four cases got well, although the other three had refused to respond to surgical treatment.

After the suppuration in the middle ear disappears, it is of the utmost importance that the patient's *hearing be tested* in order to find out definitely how much impairment of hearing there is. Only half the battle has been won, if one clears up the suppuration only. It is equally as important that the hearing be restored as near to the normal as possible. In many instances it can be restored to absolutely normal by proper treatment. It is unfortunate that many otologists are content to allow the ear discharge to clear up and then allow the condition to go on without further treatment, with the result that the patient has impaired hearing for life. On the contrary, if one will understand that proper massage to the middle ear, either by politzerization or by catheterization, or by dilatation of the Eustachian tubes with proper sounds and bougies, will allow the hearing to come back within a very short time, he will clear up a condition within the ear so well that there will be absolutely no evidence that any infection has ever occurred. The author cannot impress too strongly upon his readers the fact that deafness is often brought about, even in adult life, by neglected ears which had a suppuration which has cleared up, but where the ears had received no attention after the suppurative process has ceased.

Acute Mastoiditis.

As the name implies, mastoiditis is an acute infection of the mastoid cells, and in the majority of cases when one speaks of this condition, he means operative mastoiditis. In many instances, with the suppuration from the middle ear cavity, there is an inflammatory reaction within the mastoid cells, but this ceases by itself within a few days, and even suppuration of the mastoid antrum will sometimes clear up without surgical intervention. However, in a certain percentage of cases, infection takes place in cells which cannot drain themselves through the incision in the ear drum and one must necessarily open up the mastoid in order to get rid of the infection.

The main *symptoms* of acute mastoiditis are those associated with the acute suppuration from the middle ear, plus an aggravation of the temperature and certain definite signs, elicited by the examiner, which are oftentimes far more significant than the subjective symptoms of the patient. The pain in the ear, as a rule, is deep-seated. There is a profuse discharge of pus, far more than can be accounted for by suppuration in the middle ear alone. At the same time, there is tenderness over the mastoid cortex which first begins at the antrum, then spreads down to the tip, and then more posteriorly. This tenderness gradually spreads from before backwards, and is so persistent that one cannot help but feel that the cells posterior to the sinus are involved—cells which cannot drain out by themselves, except by being opened up externally. The temperature under such circumstances, is persistent. It may not always be high; in fact, in some very virulent cases in which great destruction of the mastoid has taken place, the temperatures have ranged only between 100° and 101° F. Yet in other cases, which we have frequently termed latent cases, the temperature is normal, and the patient hardly realizes that there is any infection of the mastoid cells, even though there is a feeling of fullness on that side of the head and there is an excessive amount of discharge from the ear canal. Some of these cases have been allowed to go on for five or six weeks, at the end of which time, when the operation was performed, one had

revealed to him a complete destruction of the mastoid cells, with often an exposure of the sigmoid sinus and dura.

It is impossible here to differentiate the various types of mastoiditis, and the various diseases with which they may be confounded, but there are certain points of great importance. Aside from the tenderness which has been mentioned before, there are certain characteristic signs within the canal or on the drum which make it evident that a mastoid involvement has taken place. Among the most important of these are the continuous bulging of the drum with thickening, the pouting of the incision, with pulsation (often felt by the patient), and what is far more important, a sagging of the posterosuperior portion of the drum, with possibly a sagging of the posterosuperior wall of the canal. Any narrowing of the canal, associated with a middle ear suppuration, indicates that infection has taken place in the bone behind it, with insufficient drainage through the opening in the drum. Briefly, the sagging of the posterosuperior wall, associated with a profuse suppuration from the middle ear, with a pulsation of the drum and tenderness over the mastoid bone, are absolute evidences of an acute mastoiditis which warrants surgical intervention.

Within recent years, the laity have become acquainted with the significance of mastoiditis. They, perhaps, dread the *mastoid operation* more than any other operation. Yet danger from mastoiditis operated upon at an early date is practically *nil,* but the danger of the complications of mastoiditis, by delayed operation, is great. It has been recorded, in the various large ear hospitals throughout the country, that the mortality from uncomplicated mastoiditis is less than one per cent., a mortality which compares favorably with the mortality from acute appendicitis, which seems now-a-days to have become more or less of a popular disease and is hardly feared by anybody. The complications occur, as a rule, in one of two ways: Either because the suppurative process has been caused by some extremely virulent organism which destroys bone so rapidly that it is impossible to overcome the infection unless an operation is immediately performed, or because the suppuration has been allowed to go on for such a length of time that the erosion of bone,

which has taken place, goes down to the plate which covers the sigmoid sinus or to the plate which covers the dura. Even under such circumstances, a patient may get well, provided there is enough physical resistance to overcome the infection. However, patients who have been allowed to go on with a suppuration for a considerable length of time are often very much devitalized, with the result that they are unable to fight off infection as well as a healthy individual. Again, one must repeat that one should not be alarmed at the prospect of a mastoid operation; in fact, in many instances one will find that the patient is far more satisfied when the operation is proposed to him, than he was during the indefinite period when the surgeon could not make up his mind whether an operation was necessary or not—a time when it was felt that, perhaps, conservative treatment could clear up the ear condition.

The operation for mastoiditis is not a very difficult one, when performed by the expert operator, and as was stated above, the results are almost invariably good. But in order for the results to be good, all the infected matter within the mastoid cells must be cleared out, which means that every cell must be thoroughly evacuated and opened up in such a way that there is no recess left for a possible secondary infection to take place. It is not an extreme task to clear out these cells in adults, where one has the anatomical relationships well kept in mind. One must always expose the antrum sufficiently to allow of drainage and all granulations must be cleaned out. The exenteration of the cells should be continued until the plate over the sigmoid sinus is fully exposed. If the sigmoid sinus itself is exposed, one should see that the granulations over it are firm and should follow the course of the vein until the blueish tint of the normal vein is seen. He must clean out the cells which cover the dura, in such a way as to leave a clean plate, and at the same time he must inspect very thoroughly those cells which lie posterior to the sinus and which lead down below it, where it dips deeply into the jugular bulb. If all these cells are properly cleaned out, one has a cavity which is conical in form, with the base upward and the apex in the antral cavity. The average time for clearing up such an infection should

be less than two weeks, and in the majority of cases the patient should be able to leave the hospital within one week or ten days, provided the sinus and the dura have not been too considerably exposed.

If complications do occur, or if there is a possibility of a complication, because of exposure of vital parts, one must meet each condition as it arises. Again one must impress the reader with the fact that the simple infection of the mastoid itself is not a serious matter, provided a. proper operation has been performed at an early date; but if complications do occur, it is impossible to tell how far these complications may go, and to what extent the patient may be invalided. Among the more serious complications are sinus thrombosis, brain abscess, meningitis, and erysipelas.

After the patient has been operated upon for mastoiditis, the *hearing should be at once tested,* and an attempt made to restore the hearing to as nearly normal as possible, after the wound has healed. The author cannot repeat too often the fact that there are too many deaf patients in this world, who have suffered from neglect of proper treatment of their ears after acute processes have been overcome.

SUBACUTE AND CHRONIC CONDITIONS.

Among the subacute and chronic conditions of the ear, are those which deal mainly with the diminution in the hearing or a feeling of fullness in the head, which is associated either with a subacute catarrhal process in the Eustachian tube or middle ear, or with impacted cerumen within the canal. The author realizes that he is leaving many things out of consideration, but in the space which is allotted to him, he must consider the two things which are of the most importance.

Eustachian Salpingitis.

A large number of adults suffer from a diminution in hearing which is not apparent to them until the hearing becomes acutely disturbed. This may only be noticed when the patient has a bad cold in the head, or when there is some warning, by nature, such as a ringing in the ear, commonly called tinnitus. Upon examination, there may be little evidence of

any trouble within the ear itself; a moderate retraction of the drum may have taken place, the drum may have lost its translucency and its glistening appearance, and the light reflex may not be as brilliant, but, nature has made us in such a way that ninety per cent. of the hearing can be lost before one becomes aware of the fact that his hearing is not as acute as it should be. In the majority of these cases there is an inflammatory condition within the nasopharynx or of the nasal mucosa which gives rise to the trouble. One should always look for such causative factors, and while a moderate treatment of the ear may not cause any harm, the most important part of the treatment will consist in the proper attention to the conditions which are causing the middle-ear trouble. Rhinologists have been frequently accused of the crime of finding too many conditions in the nose and throat which need operative interference for the clearing up of an ear condition. However, I think that they err on the safe side when they operate upon conditions which are so apparently abnormal that the direct relationship between cause and effect can be established. Perhaps it is unfortunate that too many submucous resections of the septum have been done, too many tonsils and adenoids have been removed, without giving beneficial results, but the conscientious physician will get results if he uses proper diagnostic acumen. It is only because a patient goes from one doctor to another, that one sees what may be considered the bad results. What of the patients that have actually been cured and never have to go back to a physician again? The author considers that any gross deflection of the septum, any chronic suppuration within the sinus, any inflammatory condition of the mucous membrane of the nose, any polypoid condition of the posterior tips of the inferior turbinates, any granulation tissue in the nasopharynx or adenoids or diseased tonsils, may cause a subacute inflammatory condition within the middle ear, which will eventually result in deafness. The deafness may not come on for many years, but it is decidedly better to prevent such a condition than to allow an abnormality to persist within the nose and throat which not only may cause the ear condition, but may cause a number of other conditions within the head, which will lower the general re-

sistance of the patient and will not allow him to round out his life as he should.

Sometimes, it is better to *treat* the nose and throat by continual applications of silver nitrate or one per cent. iodin in glycerin, or the high frequency current to the nasopharynx, in order to rid the Eustachian tube of the inflammatory products within it. At the same time, one may dilate up the Eustachian tubes with proper applicators, if he has sufficient dexterity. Thus the patient, with each act of swallowing, will automatically be able to massage the ear drum. The author feels that overinflation of the drum, either by politzerization or by catheterization, is an error and will often cause more harm than good; for if one persists in applying too much pressure within the middle ear, sooner or later he will stretch the drum so much that it will be impossible for it to transmit vibrations of sound. Parenthetically, one may remark here, that very frequently deafness is caused by the improper blowing of the nose. The patient uses his nose as a trumpet and forces the air into the middle ear cavities until the drums are stretched out of position. When blowing the nose, either one nostril should be held at a time or else the handkerchief should be held loosely below the nose, if the ears are peculiarly sensitive and too much air is felt to enter them. Proper blowing of the nose after bathing is most important, as no water should be forced into the ears. The patient thinks that any inflammatory condition of his ear arising at such a time, comes from the water in the ear canal. In ninety-nine instances out of one hundred, the inflammatory condition is the result of the forcing of some water through the Eustachian tube into the ear by the improper blowing of the nose.

Impacted Cerumen.

The subject of impacted cerumen is worthy of attention, in dealing with the diseases of middle ear, because of the large number of people who have accumulations of wax in the ear canal, which gives rise to deafness or tinnitus. Strange as it may seem, although the procedure for the removal of wax is extremely simple, in many instances it is either done carelessly or else with a lack of finesse which'

is astonishing. The patient with cerumen in the ear canal, usually notices a diminution in hearing which may come on gradually or suddenly, or he notices a ringing noise in the head. Frequently, particularly during the summer, the wax becomes impacted against the drum, sometimes in only small amounts, by the accumulation of water in the canal, which swells up the wax so that the canal becomes entirely clogged.

Cerumen may be present in small or in large amounts, and the symptoms from which a patient will complain will depend greatly upon whether there is complete obstruction in the canal, whether there is an itching sensation within it, or whether there is some impaction of ceruminous material against the drum, interfering markedly with hearing and also causing an irritation to the drum membrane, with an acute myringitis. At other times, the canal may become so clogged with hardened wax, that it is almost impossible to soften it sufficiently to remove it painlessly. On account of the excessive activity of the ceruminous glands in certain individuals, wax is secreted in very large amounts, but it is usually soft and can be removed readily. Such softened wax does little harm, and seldom accumulates to a sufficient extent to cause trouble. On the contrary, in people who are working in dusty atmospheres, a certain amount of dirt gets into the ear canal which forms a nidus for the accumulation of wax upon it. Such a condition is also often present in patients who have an abnormal ear canal, with exostoses, for example, or an irritated condition from a dry eczema in the canal.

When a patient presents himself to the physician with a complaint of either tinnitus, diminution of hearing, or pain within the ear, a minute examination of the ear canal should be made, and if any wax is present, it should be removed at the earliest opportunity. There are several methods for *removing cerumen*. The removal of wax by the syringe method is exceedingly simple, if proper precautions are taken. Unless the mass is extremely soft, one should attempt to break it up or soften it by instilling drops of pure peroxid of hydrogen into the ear canal, which should be allowed to remain in place for five to ten minutes. This procedure should be repeated three or four times, before syringing is

attempted. The patient is then placed upright in a chair
and the ear thoroughly syringed out, by means of a three-
ounce piston syringe, into which is placed a solution of bi-
carbonate of soda. The force of the water should be directly
into the ear canal, so that it gets behind the mass, thus
eventually forcing it out. There can never be any injury to
the ear when it is properly syringed, but one will often find
that the mass is not softened up, even after the above pro-
cedures are resorted to, so that it may be necessary to at-
tempt to remove parts of it by means of a small curette,
after which the ear may be rinsed again. The author, as
well as others, has frequently seen an acute inflammatory
reaction of the canal wall ensue, the result of too forcible
handling of ceruminous material, or else, an actual furuncle
has developed from an abrasion of the canal wall, which has
become infected. In the hands of the physician, syringing
is the simplest and safest method of removing cerumen. It
is always a dangerous procedure to attempt to remove wax
by means of an instrument unless one has been well trained
and has good illumination. In every case the mass should
be softened up first, and then, if some of it still adheres to
the drum, the procedure with peroxid of hydrogen should
again be resorted to.

After the cerumen has once been removed, the ears of the
patient should again be *tested for hearing acuity*. Many times
a patient comes to a physician's office, complaining of dimi-
nution of hearing, and if a test is made, one will find that
the hearing is actually less than it should be. This may be
due to impacted cerumen. After the wax is removed, one
will sometimes find that the hearing is still diminished and
it will be necessary, under these circumstances, to make a
definite test to find out what is the actual cause of the trouble.
For it is always possible for a progressive catarrhal condition
of the middle ear to be present, associated with this ceru-
minous accumulation, and one must pay attention to the
proper exercise of the middle ear after the cerumen has been
removed. It may happen that the pressure of the wax against
the drum has arrested its action for a considerable length of
time, and that after its removal, a few mild treatments to
the drum will be all that will be necessary to restore the

hearing to normal. However, under all circumstances the proper test for hearing should be made, so that there will be no excuse for a patient complaining that he has had his ears neglected because no one had paid any attention to his hearing after the wax had been taken out.

Chronic Suppuration of the Middle Ear.

Frequently, adults will complain of a chronic discharge from the ear which is nauseating in odor and which is considerably irritating. This discharge may be either intermittent, recurring at repeated intervals when the patient has a cold, or it may be a continuous process. It is usually the result of some acute condition which has occurred in childhood and has never been properly attended to. Such ears deserve careful attention. They should never be neglected with the idea that they will clear up by themselves, for they are often the cause of a brain abscess or meningitis which will not reveal itself until some sudden, acute illness occurs. As a rule, the patient comes to the physician, complaining either of deafness or of a great amount of discharge from the ear canal, often with a nauseating odor. If a thorough examination is made, it will be found that the discharge from the middle ear is through a small perforation in the drum membrane; or, in many cases, from a middle ear which is fully exposed because most of the drum membrane has been destroyed. In the intermittent cases, it will frequently be noted that the discharge only occurs when the patient has an acute process within the nasopharynx, with the result that he draws the secretions from his throat up through the Eustachian tube into the middle ear through the ear canal. When the Eustachian tube is open at both ends, as happens in a case where the drum has a permanent perforation, secretions are forced up through the tube by capillary attraction. This has a two-fold action. The middle ear, having been previously diseased, has a tendency to discharge from the condition therein, but secondly this is often aggravated by the secretions which come from the throat, and, strange as it may seem, frequently, when the Eustachian tube is closed off, the middle ear will take care of itself, and will remain completely dry.

In the majority of instances, chronic suppurations from the middle ears can be kept under control by *treatment* with applications of silver nitrate, or iodin, or the instillation of drops of alcohol and boric acid. In some cases, it may be advisable to take a culture from the discharge to determine the organism and have a vaccine made up which can be administered over a prolonged period of time. In other instances, where there is actual necrosis of bone, or where there has been a cholesteatomatous degeneration of the bone within the middle ear, antrum and mastoid, it will be necessary to perform a radical mastoid operation to clear up the condition. However, there are a number of factors to be taken into consideration before the radical mastoid operation is performed. In the first place, the hearing of the individual with such a suppurative process is decidedly diminished, and if the hearing in the other ear is affected, one must be careful that no procedure is resorted to which may make the hearing worse, and, sad as it may seem, frequently after the radical mastoid operation has been performed, the hearing acuity in the operated ear is entirely destroyed. In other instances, a modified radical operation may be performed, or one may then resort to the closure of the Eustachian tube, by the method devised by Yankauer, which will prevent the discharge of secretions from the nasopharynx into the ear. Aside from the nauseating odor of the discharge, the irritation to the canal which is caused by it, and the diminution in hearing that occurs as a result of the discharge, there is always a possibility that the diseased process within the middle ear may spread to further parts, and eventually erode the bony plate over the sigmoid sinus or over the brain. If this should happen, either a sinus infection will take place resulting in a septicemia, or a localized brain abscess will occur, or in certain rare instances, a meningitis. All these eventual outcomes must be carefully considered and must be weighed against the continuance of the discharge over an indeterminate length of time. If one feels that he can keep the discharge under control, by the proper office treatment, he is always wise not to resort to operative procedures, but if the degeneration of bone has gone on to such an extent that one feels that the patient is in a dangerous condition,

as from a cholesteatomatous degeneration, for example, it is always advisable to insist upon operation before the condition becomes so grave it is a matter of life and death. The author has often stated that too many discharging ears in children are neglected, and he may also state that too many discharging ears in patients in middle life are also, too often, neglected. It was a surprising fact, during the examination for the army, at the time of the Great War, that hundreds of men presented themselves with ears which showed evidences of some diseased process and many of them a discharge from the middle ear which had persisted for an indefinite length of time. There is no doubt that no attention would have been paid to these ears if they had not been brought to the notice of the examining physicians at a time when the services of men were so needed. Some of these men were taken into the army in spite of their trouble, and, in a great many instances, had to be operated upon in order to make them fit soldiers.

The author has referred to the question of intermittent discharge from the middle ear, which occurs mainly when there is some inflammatory condition in the nasopharynx which, of course, had been caused by some diseased condition in the nose or the throat. If a person is subject to inflammatory conditions of these parts, or if he has a chronic process in the sinuses, or suffers from acute tonsillitis, or has any abnormalities within the nose or throat which may set up such irritation, it is frequently possible to clear up the condition in the ear, by the removal of the causative agent in the nose or throat. One or two points must be brought forcibly to the attention of the reader. Among the conditions which increase the discharge from the middle ear are, an abnormal placement of the muscles of the Eustachian tube, and polypoid conditions of the posterior tips of the inferior turbinates which act as direct irritants. In the first instance, the abnormal relationship of the muscles is often due to adhesive bands or polypoid tissue in the fossa of Rosenmuller. These bands, or this tissue, may readily be removed by inserting the finger behind the palate into the fossa of Rosenmuller and breaking down the tissue with the tip of the finger. In the latter instance, it is fre-

quently necessary to remove the posterior tips of the inferior turbinates so that better drainage is given for the nasal secretions. It is surprising to note how often, after these little procedures have been attended to, the patient's ears become dry and their general physical resistance is decidedly increased.

DISEASES OF THE NOSE AND NASAL SINUSES.

ACUTE CONDITIONS.

Rhinitis.

Acute rhinitis, or acute cold in the head, is a very common condition in adult life, and must be carefully considered if one desires to avoid complications, such as an infection of the nasal sinuses. Acute rhinitis is invariably caused by an infectious condition of the nasal mucosa, which sets up an inflammatory reaction, with an intense turgescence of the mucous membrane. Ordinarily, a cold in the head may be overcome in a short time by proper building up of the general condition of the patient. In other words, the majority of cases of acute rhinitis occur in individuals whose general physical resistance is below par. The causative agents in these conditions may be numerous, and if bacteriological examinations of the nasal secretions are made, very frequently the cultures will be sterile, unless a culture has been taken either from the back part of the nose or from the nasopharynx. In a large number of cases, if the patient allows himself proper elimination of the bowels, and creates a counter irritation in other parts of the body, by the use of a mustard foot bath, and has himself warmly clothed, and sees that the mucous membranes are kept in good condition by the instillation of some mentholated oil (either by drops from a medicine dropper or by a spray), he will overcome the infection within a short time. However, repeated colds in the head are usually caused by some exciting agent within the nose, or throat, and the only way to rid the patient of the continued trouble is by an elimination of this factor. The infection itself may be due to a polypoid degeneration of the mucous membranes of the turbinates, or a marked deviation of the septum with a spur causing irritation of the parts,

or the tonsils may be chronically infected and thus set up a repeated irritation of the mucous membranes of the nose.

In common, everyday practice, it is wise to shrink these membranes up with a mild solution of cocain and adrenalin, to make a proper examination, but under no circumstances should such a solution be given the patient himself. The rest of the *treatment* should consist in the spraying of the mucous membranes with some cleansing alkaline wash and a mentholated oil. But what is of the greatest importance, is the building up of the physical resistance of the patient. It is a surprising fact, but one which should be readily understood, that people who lead an outdoor life and who are not changing from one atmospheric condition to another, seldom have colds in the head, provided there is not some absolute abnormality in the nose or throat which causes an irritation.

Sinusitis.

In this twentieth century, when diseases of the nasal sinuses are the common knowledge of all practitioners, as well as specialists in nose and throat diseases, it seems hardly relevant to dwell too long upon this particular phase of the matter, except insofar as is necessary to impress upon the physician the necessity of knowing that when a rhinitis, or a coryza, or an infection of the nose and throat takes place, which does not respond to the treatment ordinarily given, one must look for further causes for the aggravation of the trouble. The nasal sinuses are so situated that they are necessary for the complete drainage of the nasal chambers and for the proper ventilation of not only the nose and throat, but of the ears as well. While the moist mucous membrane is in a normal state, a certain amount of mucus is secreted by these chambers, sufficient to keep them in a moist condition at all times so that any foreign particles which may be irritating may be kept from invading the system. However, once the mucous membrane becomes inflamed, or the natural openings to the sinuses become clogged, immediately a congestion takes place within the sinuses themselves, with a resultant exudation. This secretion is infectious although it may not contain actual pus. When such a state of affairs does occur, it is necessary that the infectious agent be elim-

inated as quickly as possible. In the majority of cases, where either the antra or the frontal sinuses are affected, it is not very difficult to diagnose the condition, particularly if there is acute pain associated with it, for the patient will frequently refer to the part that is affected, and will complain of severe pain or tenderness in that region. As soon as pain or tenderness is complained of, it is the duty of the physician to eliminate the causative factor as soon as possible, which may readily be done by washing out these chambers with any mild alkaline or antiseptic solution. However, there may be no such complaint when either the ethmoid cells or the sphenoid sinuses are involved, and it has been definitely proved today that there are many indefinite generalized conditions of the system which are caused by a latent sinus disease which very frequently cannot be discovered, even when the most acute and accurate x-ray pictures have been taken. For example, we are all aware of the fact that certain affections of the optic nerve are caused by improper aëration of the posterior cells, such as the posterior ethmoidal cells and the sphenoid, and that these affections of the optic nerve can be cured in one way only, and that is by opening up these cells, either by the total or partial removal of the middle turbinate and the exenteration of whatever diseased condition of the cells is found. Very frequently simply the opening of these cells, either with the total or partial removal of the middle turbinate, will result in cure. Moreover, in careful investigations which have been going on for the past two years, particularly in children, it has been found that there are certain definite cases of arthritis which have not been cured or even improved, by the removal of the tonsils and adenoids, and that the cause of the trouble has been in the nasal sinuses, the proof of which has been that the arthritis has been cured or considerably improved after the sinuses have been properly cleaned out.

However, it is wrong for one to become too radical in the *treatment* of these conditions, and it is a question in the mind of the author whether too many sinuses are not opened up promiscuously now-a-days, by individuals who are not thoroughly versed in the symptoms which present themselves and the results which can be obtained. Today, we have so

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many conservative means at our command for combating these conditions, that each one of them should be employed in turn, to see if it is not possible to avoid an operation, for an operation on any sinus is not devoid of danger and possibly a chronic infection may arise unless the greatest care is taken. Retention of secretions within the sinuses is almost invariably caused by the clogging of the normal openings, and the making of an artificial opening to overcome this trouble sometimes results in unnecessary inconvenience to the patient. How much better it is, under all these circumstances, to shrink up the membranes of the nose thoroughly with a dilute cocain and adrenalin solution, and then to attempt to draw out the plug of inspissated material, in the normal opening, by means of suction, caused by either a water or an electric pump. In many instances we have found it possible, in our office, to clear up an acute sinus infection by these means, without going through an operative procedure. In other words, in the majority of acute sinus infections, one should use every conservative measure possible, before he resorts to any radical procedure, such as an operation. One is liable to be misled under many circumstances, even with the best transillumination and by the x-ray, for frequently one can see shadows that will indicate a diseased condition which looks as if it could not respond to anything else except operation, and yet, the symptoms will often disappear, within a short time, when ordinary conservative measures are used. In the majority of cases of acute infection, one sinus only is seldom involved. In other words, there is an inflammatory reaction of the rest of the sinuses which has to be overcome at the same time. It is impossible to open up all these sinuses, in fact, it is far too dangerous a procedure. One must work, not only to eliminate the inflammatory condition within the nasal chambers, but at the same time must be very careful to build up the general physical condition of the patient.

However, in certain chronic conditions of the sinuses, one cannot be content to resort to simple, remedial measures. In these cases operations are often necessary, and this applies particularly to the suppurative conditions of the antrum. However, the suppuration may not be cured by an intranasal

opening of the antrum by itself. Often there is a carious condition of the maxillary bone, or else there is some diseased tooth which is accountable for the trouble, and therefore the patient needs the advice of a competent oral surgeon. If there is a chronic condition of the frontal sinus, radical measures intranasally may be employed, such as the removal of the middle turbinate and the anterior ethmoid cells, followed by continuous washing out of the sinus. In very rare instances, it is necessary to do an external frontal sinus operation, but where such an operation is necessary, the patient should be placed in the hands of a man who has the utmost skill in doing operations of this kind.

By far the most interesting sinus cases, in adult life, are the *indefinite sinus inflammations which affect the general physical condition of the patient.* Among the systemic symptoms are acute and chronic arthritis, various eye conditions such as iritis and optic nerve lesions and the general toxemias or sapremias. When x-ray pictures of such cases are taken, no evidence of any diseased condition may be found, and a thorough examination of the patient's nose may reveal no pathological condition of any importance. Yet, it is a well known fact that when these sinuses are thoroughly opened up and drained, the general physical condition of the patient improves markedly and very often the localized condition in the eye will be absolutely cured. A statement such as this is liable to lead to radicalism, but one must feel that in certain cases it is a wise policy to do an exploratory operation upon these delicate structures, even when there are negative findings. There are certain indefinite neuralgias radiating over the side of the face, along the course of the supraorbital nerve and over the temporal region, and there are indefinite, deep-seated headaches, which radiate towards the occipital region, which cannot be accounted for by the ordinary examination which is made. Many of these headaches are due to some indefinite sinus disease and can be eliminated if a sinus is properly ventilated. The author recalls distinctly one case of a young girl who, for years, had suffered from supraorbital and pericranial headaches which could not be relieved except by the constant use of analgesics. An inspection of the nose showed two large middle turbinate bones

which were pressing upon the septum, causing an irritation of the anterior ethmoidal nerves. A resection of both of these middle turbinate bones resulted in absolute cure of the headache. Such a marvelous result cannot be promised in many cases, yet, it is surprising how, sometimes, the relief of pressure causes a number of reflex symptoms to disappear which could not be overcome by any other means. Sinus conditions are readily diagnosed today and the laity are well acquainted with the possibility of complications from neglect with the result that more expert attention is given to these cases than formerly.

It is therefore not uncommon to have adults immediately consult the specialist as soon as they have a neuralgic pain in the head, for which they cannot account; and if they are taken in hand at once, the inflammatory condition in the mucous membranes may be so overcome that one is able to reduce the inflammation to a minimum and to drain the sinuses within a short time. If, on the contrary, these patients wait an indefinite length of time, until the mucous membranes of the sinuses become chronically diseased, it will be many months before any results can be attained, and then it may be necessary for them to return at frequent intervals, whenever an acute condition lights up upon the chronic one. For it is only too evident that when a chronic inflammatory condition of the mucous membranes has occurred, the tendency is for an acute condition to impinge itself upon the chronic one, causing the patient a great deal of distress and considerable worry.

SUBACUTE AND CHRONIC CONDITIONS.
Catarrhal Affections of Nasal Mucosa.

We now come to the subacute and chronic catarrhal conditions of the nasal mucosa. In persons who live in large cities, such as New York, there is always a vast amount of infection, due to a variety of bacteria which may cause a lighting up of acute infection or may continue a subacute condition which gives a great deal of trouble. Although bacteria are mainly responsible for these conditions, at the same time a definite change takes place in the mucosa, particularly

during the middle ages of life, which makes it necessary for us to take care of the condition properly or else the patient will suffer a great deal of inconvenience and perhaps serious results may occur. Not only are *bacteria responsible* for these conditions but a *variety of abnormalities* within the nasal chambers which in many instances must be corrected, may cause an altered breathing mechanism. Here the author wishes emphatically to state that, although the abnormality may need operative interference, in many instances, too many mutilating operations are performed, with the destruction of too much mucous membrane. One must realize that the mucosa of the nose (and this applies to the mucosa of the sinuses, as well) has a very definite function. It allows of the secretion of protective mucous which will take care of any irritating substances, such as dust and bacteria, which may get into the nasal chambers and be breathed in further down. Among these abnormalities which may need attention, may be mentioned deviations of the septum, thickening of the septum, inflammatory conditions of the mucosa of the septum, and hypertrophy of the mucosa of the turbinate bones, particularly the anterior tips of the middle turbinates and posterior tips of the inferior turbinates. One may determine how much actual thickening has taken place in the tissues if he will shrink up the mucosa with a spray of cocain and adrenalin, or if he will insert pledgets of cotton into the nose high up against the middle turbinates, which have been immersed in a similar solution. An important point which must be taken into consideration here, is the fact that mucosa which will not shrink, under the ordinary administration of cocain and adrenalin, suggests that there is a possible specific condition at the bottom of it. The author, within the last few months, has encountered two such cases where it was possible for him to make the diagnosis of syphilis (corroborated later by a four plus Wassermann), by noting that these mucous membranes did not shrink under the action of cocain and adrenalin. Conservatism must always be kept in mind when operating upon these tissues, if one does not wish to destroy the ciliated epithelium which is normally present and supply for it a squamous epithelium which has no power to protect the nasal chambers and the air passages

further down. However, the performance of any special or any single simple operation upon an abnormality within the nose, will frequently not correct the subacute or chronic condition which is present. In other words, the nasal chambers are a complex series of cavities which are seldom made abnormal because of one particular deformity. With a deviation of the septum there is frequently found a polypoid condition of the posterior tips of the inferior turbinates, or in other instances the middle turbinate impinges upon the upper portion of the septum, not only causing a subacute catarrhal condition, but at the same time causing certain neuralgic headaches due to the pressure of these bones upon the anterior ethmoidal nerves. Although one should exercise conservatism in every instance where it is possible, at the same time if an operation is to be performed upon the nose to give better breathing or better ventilation to the ears, one must search for all abnormalities and correct these all at the same time, if he desires to get a perfect result. This not only includes the correction of abnormalities within the nasal chambers themselves, but the searching for diseased conditions within the sinuses which may cause an irritation to the mucosa of the nose. The most common of these diseased conditions are infections of the antra, and when operations are performed upon the nasal chambers in order to clear them up entirely, it is frequently necessary to make an opening into the antrum which will allow of better drainage of these cavities or allow them to be washed out properly.

We have found it of importance in almost all cases of subacute infections of the nasal chambers in adults, to attempt to culture the bacteria which are causing the infection. Cultures which are taken from the anterior nasal chambers are invariably sterile and it is impossible to get any growth for the preparation of a *vaccine*. However, if one will shrink up the nose properly and apply a culture swab to the nasopharynx, or will lift up the soft palate and make a culture from the nasopharynx through the mouth, invariably he will obtain bacteria which are of importance and from which a suitable vaccine can be made. Vaccine administrations as a rule, in subacute and chronic infections of the nose and sinuses, cause a great deal of improvement in the patient's

local and general physical condition. The vaccine should be administered at least twice a week over a definite period of time until the proper result is obtained. It is our experience that after ten injections, the majority of which consist of fifteen minims of a vaccine of five hundred million bacteria to the cubic centimeter, the patient will be much benefited. Of course, in many instances, the definite bacteria causing the infection are not found and so the administration of the vaccine does very little good. Our experience with commercial vaccines has not been very satisfactory.

Among the chronic catarrhal conditions that are of importance there are those that are associated with a dry catarrh of the nose and an irritation of the mucosa due to some latent sinus infection. An instance of the former is atrophic rhinitis or ozena.

Atrophic rhinitis is a chronic disease of the nasal mucosa resulting in the formation of crusts and usually giving forth a nauseating odor. It is generally a non-specific condition, and is extremely baffling, resisting most of the known forms of treatment. In our routine office practice we have tried every known method of treatment, and, today, we are not in the position to state specifically what definite thing can be done to correct the terrible crusting and odor. Of primary importance is the proper cleansing of the nose and here it is necessary to point out that the habitual use of alkaline or watery solutions, within the nose, inclines the patient to have an atrophic condition of the mucous membrane which it will be difficult to correct later on. If one uses any form of douche within the nose, be it whatever solution he desires, it is absolutely necessary that this douche be followed by the application of some oily medicament so that the mucous membranes are not without some protective covering. In other words, if the mucous membranes are too thoroughly cleansed, there is a decided irritation takes place within the nasal chambers. A certain amount of mucous is protective.

The problem in atrophic rhinitis is to get rid of the crusts and the odor. This can only be done intelligently by *eliminating all causative factors.* If one takes cultures from various parts of the mucous membrane, he may be able to discover some definite forms of bacteria such as the Friedlander

bacillus, which may be cultured and later made into a vaccine which should be administered until an appreciable change in the mucosa is seen. Certain specific bacteria are supposed to be responsible for atrophic rhinitis, but it is questionable whether they are the cause of the condition. The author is of the opinion that a great many of these cases start from a latent sinus disease in childhood, which has not been properly corrected, with the result that the mucous membrane is constantly bathed in a pus-like secretion which causes considerable irritation and finally a change from a ciliated mucous membrane to a squamous one. The drying of the mucosa usually occurs in the nostril which is larger and therefore attempts have been made to narrow this nostril, either by the injection of paraffin under the mucosa or by resetting the septum to the opposite side, so that less air will enter. However, for ordinary purposes, the cleansing of the mucous membranes daily, by wiping out the crusts and making an application of a four per cent. scarlet red emulsion, will have an excellent effect. Lately, we have been using a thirty-three and one-third per cent. salvarsan ointment. But although one may expect relief from constant treatment, he will seldom effect an absolute cure. In one or two instances, where the sinus condition has been discovered and properly treated by operative means, the atrophic condition of the mucosa has become arrested and the patient has been able to get along very well. But, under no circumstances should definite promises be made. In order to lessen the dryness we have advised our patients to insert pieces of cotton which have been immersed in liquid albolene, into the nose, every night, and to remove them a few hours after arising in the morning. This mild and simple treatment will frequently keep the mucous membranes in a moist, oily condition for a great part of the day, and the patient will not have the discomfort that usually arises if only watery solutions are used.

In attempting to correct chronic catarrhal conditions, either of the sinuses or of the nasal chambers, one must realize that he is treating a condition which has gone on for a great many years and that it is impossible to make definite promises of absolute cure to patients, even if operative procedures are

employed. However, in the majority of instances, the proper cleansing of the mucous membrane, and stimulation, either by silver nitrate or by argyrol or other medicaments, will tend to keep the patient in a comfortable condition so that it is only necessary for him to come for treatment at stated intervals. One frequently comes across patients who have had numerous operations performed, with promises of cures, but the cures have not resulted, so that one must be extremely conservative in stating to a patient that any definite operation will cure a chronic condition of the nose. Oftentimes the harm has been done in years gone by, and although there may be a tendency to an arrest of the condition by proper operative means, it is almost impossible to replace the destroyed mucous membrane by new mucous membrane. On the contrary, in many of these instances, if the patient leaves the climate in which he resides and goes to a drier and more equable one in which there are not radical atmospheric changes, such as occur in a large city, it is surprising to see how little trouble he will have with his nasal mucous membranes. The author, as well as others, has seen patients who, having gone from New York City to the mountainous regions of South Carolina or to the mild coast of southern California, have been absolutely relieved of their nose or throat troubles. And yet, as soon as those patients have returned to the city, they have immediately had a return of the old condition. It is indeed fortunate that for many years a chronic condition of the mucosa does very little harm to the patient as far as his general physical condition is concerned, but the time comes when the improper inspiration of air results in a chronic infection of the lungs, such as an empyema, a chronic bronchitis, or asthma. In many instances, there may be an infection of the ears giving rise to a progressive deafness. It is because of these later complications that one has to be particularly careful that the nasal mucosa be kept in as clean a condition as possible.

In a résumé of the chronic conditions of the nasal chambers, one must mention the various forms of chronic catarrh which are caused by a persistent *irritation of the ethmoid cells.* This irritation may result merely in the hypertrophy of these very fine little cavities, or may result in actual hypertrophy

of the mucous membrane of the middle turbinates, or in many instances, in the formation of large polypi. These polypi may be large enough to almost protrude from the nostril. The removal of the polypi by themselves will not clear up the condition; for there is a chronic inflammation of the mucous membranes of the ethmoid cells, which must be eradicated. If it were only a question of relieving the nasal obstruction, one would not hesitate to remove any polypi causing obstruction and expect relief, but in many of these cases there is an associated condition in other parts of the body, reducing the patient's vitality or else resulting in a chronic asthma which cannot be cured until the ethmoid cells are properly cleaned out.

Anaphylactic Reactions.

Among the conditions of the nasal mucous membranes, during middle life, which one must consider seriously, are the anaphylactic reactions which occur with exceeding frequency and are often unexplainable. Reference is made to *rose cold, hay fever,* and the *rhinorrheas* which give rise to an edema of the mucosa of the nose. Nor is this edema simply confined to the nasal mucous membranes, for it often extends down the pharyngeal wall and into the bronchi, causing distressing asthmatic attacks. Formerly one considered that hay fever was a nasal condition and various operations upon the nose were performed to give better breathing space. However, it is a well recognized fact, today, that hay fever, as well as other anaphylactic reactions, are due to some protein poisoning in the system, and for that reason scientists have been working on the theory that the pollens of plants are responsible for hay fever conditions. Within recent years, it has been possible to obtain the various proteins or pollens, and to test out the patient to see which ones give the severest reaction. After a proper determination, it is often possible to inoculate the patients against these various pollens. It is impossible to go into the discussion of the various theories of anaphylaxis or hypersusceptibility. But one knows that certain individuals are susceptible to particular proteins, such as strawberries, fish, lobsters, milk, etc. (See Hay Fever, Walker, page 862.) Although it is possible to allay the inflammatory reaction

inside of the nasal chambers by the application of adrenalin and other suitable adjuvants, yet such remedies are simply temporary in their relief and the patient is bound to have a return of the distressing condition at a future time. The author would feel considerably encouraged if he could become convinced that the testing out of the individual against the various pollens, and the application of vaccines to the individual, would clear up the condition, but he has observed that the patient is frequently not cured by the inoculation of one individual pollen, or a combination of pollens, or by the elimination of other foreign irritants. In other words, there is some other factor which has not been discovered as yet, which is partly responsible for the reactions of the mucosa towards the irritation at certain seasons of the year, giving rise to what is commonly called the rose cold or hay fever, or a continual congestion throughout the year. It may be possible that in the course of time this special factor will be discovered and it is more than possible that this factor is some nervous reaction against the external excitant which must be overcome in some special way.

However, we are mainly concerned with the question of the various rhinorrheas and the so-called pseudo-hay fevers which occur during the winter months. In many instances, one will have patients come to him who complain of frequent sneezing attacks, a distressing feeling in the head, and constant engorgement of the mucous membranes with a considerable exudation of mucus and serum. It is impossible for the individual to overcome this reaction by local treatment, and frequently he is so distressed that it is impossible for him to lead an agreeable existence. What can be done for such individuals? To attempt to remove mucous membrane, or bone, which seems to be the cause of obstruction in such instances, is a most pernicious method of relief. In fact, it seldom does any good. What is necessary is to find the special hypersusceptibility of the individual and eradicate that particular irritant which is invading the system, whether it is an external poison or an internal posion. Among the external poisons are the various proteins of food and animal emanations, such as horse dander, cat fur, etc. It is a surprising fact, but well worthy of comment, that in the majority

of these cases, if a patient is tested out against all the various foods which he is in the habit of eating, and also against the various external foreign proteins, such as horse dander, some reaction can be found against one or two of these which, when eliminated from the system, causes a cure of the condition. However, in other instances, the patient shows a general erythema, by the test, for every one of the foreign proteins. In such instances, in nine cases out of ten, the cause of the trouble is some intestinal irritation which must be overcome by the elimination of various foods, by the adherence to a strict diet, and also by attending to the thorough cleansing of the bowels and the attempt to eradicate any diseased condition which gives rise to bacterial fermentation. In one case which has recently come to the notice of the author, the individual was so incapacitated as a result of a rhinorrhea and sneezing that it was impossible for her to continue with her work. A test made of the various proteins showed a general erythema—in other words, there was no protein which predominated over the other. A careful testing of her intestines showed there was a decided putrefaction present. The patient was put upon a rather strict diet and she was inoculated with vaccines from bacteria in her intestinal canal. It was thus possible to almost completely overcome the condition. However, it may be necessary in some of the cases to do some nasal operation in order to correct the deformity which keeps up the irritation. But it is preferable that the operation be done last instead of first. One cannot insist too strongly that cases of nasal obstruction are not always due to something in the nose *per se,* or, to put it in other words, the obstruction in the nose is caused by some irritant in the body which does not allow the mucosa of the nose to resume its normal function. In such instances, it is always necessary that the original source of irritation be discovered and be eliminated as quickly as possible, surely before any advice is given that a nasal operation be performed.

DISEASES OF THE THROAT.

Tonsillitis.

Among the multiplicity of throat affections that can occur during middle life are the tonsillar infections, particularly

tonsillitis, both acute and chronic. One would not have to take tonsillar infections very seriously if it were not for the systemic sequelæ which occur so often.

Acute Tonsillitis. This is invariably an infection from virulent mircoörganisms which have a tendency to promote their toxicity throughout the body, and in certain instances, the bacteria themselves escape into the blood-stream. An acute tonsillar infection can be taken care of readily and will pass off by itself in the course of a few days, under the simplest treatment, but unfortunately the systemic reactions which occur as the result of it are such that there may be a chronic ailment which cannot be eliminated by the usual means at our command. It is of the utmost importance, as soon as a tonsillar infection occurs and the crypts are seen to be filled with pus, that a culture be taken in order to determine the exact organism which is causing the infection. This will at the same time eliminate both Vincent's angina and diphtheria. It is surprising to see in how many cases a diphtheritic infection can take place which will result early in a cryptal infection and look exactly like tonsillitis, and the only means of determining the difference between the two conditions is to take a culture and examine it microscopically after twenty-four hours. As a rule, the temperature in acute tonsillitis is high (between 103° and 104° F.), and this in itself will differentiate it very often from diphtheria where the temperature is low. In fact, one of the diagnostic points between diphtheria and acute tonsillitis is, that in the former infection, the temperature does not go very high and the systemic reaction is late, while in the latter the temperature is extremely high and all the symptoms of fever appear early. Patients with acute tonsillitis demonstrate systemic infection at the outset by a feeling of malaise and definite, acute· pains in the joints.

The patient should at once be put to bed and *treated* systemically. Aspirin is almost a specific in these cases, and five grains, every four hours, with equal amounts of bicarbonate of soda, should be taken (twenty or twenty-five grains in the course of the day), and the patient should be instructed to gargle with a solution made up of twenty-five grains of aspirin in a half glass of water. An ice-bag should be ap-

plied to the neck, and the patient should remain in bed until all general symptoms have disappeared and the temperature is normal. Blood counts, at the time of the acute infection, will show that there is a rise in the polymorphonuclear count and sometimes, when blood cultures are taken at the height of the fever, a positive blood culture can be demonstrated. This is not usually so, because the symptoms which occur are often due more to the toxic effects of the bacteria than to the actual bacteria themselves.

In order to reduce the localized inflammatory reaction, to make the patient more comfortable and at the same time to eliminate the infection from the crypts, one may be able to shrink up the tonsil considerably by the application, under direct illumination, of a fifty per cent. silver nitrate solution. The application of this medicament should be made with the utmost care, and one should see that the medicine is applied chiefly into the crypts and not over the entire surface of the tonsils and on to the fauces. As soon as the application is made, the tonsils will appear white and will become considerably less in size. This will allow of the opening of the crypts and thus the infection that is within will have a better chance to evacuate itself. Very often, an acute tonsillitis can be aborted by the application of this medicine within the first twenty-four hours. Another soothing medicine which does a great deal of good, is the old Jacobi mixture of ferric chloride, potassium chlorate, glycerin and water. A teaspoonful of this mixture should be taken every four hours, gargled, and then swallowed. An ice-bag should be applied around the neck. If rheumatic pains of a definite nature occur at the time of or after the tonsillar infection, one should examine the heart and kidneys carefully in order to determine whether there is any systemic infection. After such sequelæ have been sufficiently overcome, the tonsils should be removed at the earliest opportunity. One will be surprised to see how often there are encapsulated abscesses within the tonsillar parenchyma, which can only be eradicated by the removal of the tonsils.

Chronic Tonsillitis. Serious consideration should be given to the question of chronic tonsillitis in adults, or chronically diseased tonsils. At the present time many tonsils are be-

ing removed, from patients between the ages of twenty and fifty, for various systemic infections and also for localized irritations or reflex symptoms. It is a surprising thing that, although a few years ago very few adults presented themselves for tonsillar infections which warranted surgical intervention, today a great many individuals who are examined show not only evidences of hypertrophied tonsils but systemic reactions from small tonsils which are deeply buried. It is hard to explain the reason for the large number of tonsillar infections seen today except that, apparently, organisms have peculiar differences of virulence from year to year, and that certain organisms will attack one part of the body one year and another part another year. The *Streptococcus hemolyticus,* for example, two years ago, attacked the mastoid bone with a great deal of severity and a great many patients had to be operated upon for acute mastoiditis. In the following year, these infections attacked the tonsils, causing both local and systemic infections. However, it is not so much a question, oftentimes, of the kind of organism which is present, as it is the virulence of the organism in a particular season. Today there seems to be a change in organisms, so that bacteria which were not present before are now showing themselves, many of which are accountable for a great many systemic symptoms. For example, a few years ago, one heard of the Connellan-King diplococcus, which, apparently, today has passed out of existence, and now we, in our own laboratory, have observed a peculiar, Gram-negative, small bacillus which has never been described, an organism which seems to be accountable for certain systemic reactions. This organism, in the course of another year or two, may disappear, and another new organism present itself which will cause the same trouble. So one must discriminate very definitely between the types of infection which occur in tonsils and the results that occur from their virulence. It is not always possible to determine by the size of a tonsil exactly the amount of infection that is present. In fact, some tonsils which are extremely small, are the ones that cause the most trouble. In order to determine a pathological tonsil, one should first search for enlargement of the tonsillar gland. If this gland is markedly pal-

pable, one may rest assured that some absorption is taking
place from the tonsil, no matter what its size. The next
step is the examination of the tonsil itself, both by inspection
and palpation. The latter procedure will give an idea of the
depth of the tonsil. Finally, the massage of the anterior
pillar will allow of the expression of infectious matter which
can be readily cultured. These examinations are decidedly
better than the mere inspection of the tonsil which, very
often, will tell you nothing. For today, the judgment as to
whether a tonsil should be removed or not will depend upon
a great many factors, chief among which are the amount of
local infection seen, the cultural characteristics of any pus,
the size of the tonsillar glands, and the extent and degree
of severity of the systemic infection.

Peritonsillar Abscess.

During the course of an acute tonsillitis, or spontaneously,
an abscess may appear in the superior tonsillar fossa, or
posterior to the tonsil, called peritonsillar abscess, which will
cause a great deal of pain and which presents itself as a
definite abscess. In the majority of cases there are certain
specialized symptoms present which allow of a diagnosis
without any great difficulty. However, in a small number
of cases, the diagnosis is not simple, and can only be deter-
mined after expectantly waiting for a few days to see whether
any actual edema of the tissues occurs, with engorgement and
swelling of one side of the throat. Naturally, if a person has
had an acute tonsillitis, and suffers a great deal of pain on
one side of the throat, with some swelling, there is little
doubt that pus is still present, but oftentimes these abscesses
are deep-seated and will not reach the surface for quite a
few days.

The definite symptoms of peritonsillar abscesses are, the
swelling of one side of the throat, a bulging of the tonsil
towards the median line, slight temperature, a great deal of
severe pain which radiates towards the ear on the affected
side, difficulty in swallowing, a thick voice, an increased
amount of tenacious mucus, and the inability of the patient
to open his jaws more than a half inch or so. When such
symptoms present themselves, in all likelihood, one can easily

determine that an abscess is present which must be opened up at once. However, in other cases, the patient merely complains of a very severe pain in one side of the throat, and as no localizing symptoms are present, it is almost impossible to make a definite diagnosis. Patients with those indefinite symptoms will go on for a considerable length of time, only complaining of difficulty in swallowing, until the abscess ruptures spontaneously, or until an exploratory incision is made. The author has seen cases in which there was very little swelling and yet with acute symptoms so marked that the patient has been prostrated.

If the symptoms are manifest, so that one feels that the *abscess must be opened* at once, the most important thing is to determine the exact point for making the incision. It is surprising to see how often these abscesses are missed by the physician because he does not choose the right place. If one will draw an imaginary line through the base of the palate and another line at right angles, along the free border of the anterior pillar, and will make his incision at the junction of these two lines, he will almost invariably strike a peritonsillar abscess. It is unnecessary to use a protected knife blade, in fact, it is better, in most cases, to use no knife at all. One should employ a sharp-pointed, dressing forceps or nasal forceps, which will penetrate the tissues very readily. The forceps is inserted at the point mentioned above, pushed in forcibly, until one finds that he is beyond the resistance of the inflamed tissues and has entered the cavity. As soon as he gets into the cavity, he should immediately spread the blades of the forceps, so that the tissues are torn along the line of the muscular planes. There will almost invariably be an evacuation of a large amount of pus, whereupon the blades of the forceps may be removed. Such an operation should not be performed under anesthesia, particularly gas anesthesia, as a number of deaths have been reported from edema rapidly spreading to the larynx. It is far better to paint the surface of the abscess with cocain, which does little good, except for its mental reaction upon the patient. The operation should be done quickly and in such a way that the patient hardly realizes what is being done to him until the incision is made. In almost every instance, the patient will

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suffer acute agony at the time of operation, and will complain of a severe radiating pain that goes towards the ear, but the relief from the evacuation of the pus is almost instant, and the patient is indeed grateful within an hour or so that the abscess has been opened.   The patient should then be in- structed to gargle with peroxid of hydrogen, or with a gargle of twenty-five grains of aspirin to a half glass of water. The neck should be massaged on the outside, at frequent intervals, either by the patient himself, or by an attendant, to evacuate what remaining pus is present, and the patient should be allowed to have an ice-bag around the neck. Rest in bed is an absolute necessity until the patient regains his strength.   Most of these patients are considerably prostrated as a result of the abscess, and the lack of intake of food for so many days.   It is seldom necessary to make a second and third incision, although one should penetrate the incision with a small probe, either the same day or the following day, and, when the patient is able to come to the office for treat- ment, a suction tube should be inserted into the abscess cavity and whatever contents there are within, should be withdrawn and then an application should be made of a tinc- ture of iodin solution.   Under all circumstances, the patient should be advised to have the tonsils removed, for the only absolute cure of peritonsillar abscess is the removal of the tonsils.

One usually thinks that a peritonsillar abscess occurs in the superior tonsillar fossa. This occurs in 90 per cent. of the cases, but, in the other percentage, the abscess may oc- cur in any of the loose areolar tissue behind or to the out- side of the tonsil.   If it is in these latter locations, it is almost impossible to judge exactly where the point of least resistance will be or where is the best point to penetrate the cavity. The author has seen a number of cases in which it has been necessary to make multiple incisions and sometimes it has been necessary to sever the tonsil from the anterior pillar, before there was an evacuation of pus. Some writers advise, at the present time, the enucleation of the tonsil, at the time of the peritonsillar abscess. Their contention is that the operation is simple because the tonsil has been separated from its bed by the burrowing of the pus. The

author feels that this is a dangerous procedure at the present time unless it can be done under local anesthesia, or no anesthesia at all.

Vincent's Angina.

Vincent's angina is a term applied to an infection of the throat which occurs from organisms, called the Vincent's spirillum and the Vincent's bacillus. As a rule, the infection occurs on one side only, in the beginning, and manifests itself by small superficial ulcerations, with sharp grayish-black edges. Sometimes, the ulcerations are no larger than the head of a pin, which give as much pain as a large ulceration which covers a considerable area. One often is inclined to feel that the infection is diphtheritic, and the only way that one can tell whether this is so or not, is by taking a smear and making a culture. The smear should be transferred to a glass slide and examined under the microscope after being stained with a Loeffler solution. If Vincent's angina is present one will see the characteristic spirilla and long bacilli of Vincent. These organisms will not grow, so the diagnosis has to be made from the slide.

After the diagnosis of Vincent's angina is determined, the local *treatment* should be directed toward the cleanliness of throat and application of tincture of iodin followed by the application of salvarsan. In the past, it has been very difficult to apply salvarsan locally to the throat, but within the last year, the author has had an ointment made, of a thirty-three and one-third per cent. salvarsan, which can be applied with the utmost facility. If this treatment is employed at once, the ulcerations will disappear within a short time and no further effects will be noticed. However, in certain instances, where the patient's general vitality is considerably below par, the infection will last for some time and another part of the throat may become infected. In such instances it is necessary to build up the general system by tonics and at the same time, in the more severe cases, to give intravenous injections of salvarsan which have almost a specific effect.

Pharyngitis.

Among the other common lesions of the throat are the various subacute and chronic inflammatory conditions which result in an inflammation of the mucous membranes, extending along the pharyngeal wall, sometimes down into the larynx. The pharyngitis and the inflammation of the surrounding tissues is almost invariably caused by localized irritation or by some infection of the nose or sinuses, with a dripping of mucus down the back of the throat. It is almost impossible to go into the exact etiological factors in every case, but the author wishes to emphasize the importance of making a search for nasal sinus disease.

The *treatment* should not be directed entirely to the pharyngeal wall but should be directed towards the etiological factors. When these are once eliminated, one will seldom have any trouble. Of course, it is necessary to remember that the numerous climatic changes which take place, in a large city like New York, tend to irritate the mucous membranes of the nose and throat considerably, and one will often have a dry pharyngeal wall or a tenacious secretion which will only respond to localized applications of silver nitrate, argyrol, or an iodin in glycerin solution. In fact, many of the cases of subacute laryngitis which come to the physician, are secondary to pharyngitis or nasal sinus disease, which must be treated, after which the laryngitis will disappear.

At this point, it might be wise to mention the value of *x-ray treatments for various lesions of the pharynx, nasopharynx, and the tonsils.* A great deal has been written upon the reduction of tonsillar tissue and the sterilization of infected pharyngeal glands by the application of the x-ray. The author does not wish to commit himself here, except insofar as to say that he believes that the only ideal way to eliminate tonsillar infection is to remove the tonsils, yet in certain individuals (and this applies to children as well as adults), there are various inflammatory conditions behind the palate, with nodular excrescences upon the pharyngeal wall which cannot be removed by the ordinary methods in vogue. These nodes can often be considerably reduced by the application

of the x-ray. This applies particularly to those patients who have a pharyngeal inflammation which affects the Eustachian tube. When there are glandular infiltrations around the tube and glands extending down the pharyngeal wall into the hypopharynx, the best treatment is by the x-ray. Whether the treatment has a direct effect upon the ear itself or whether the result of the treatment is merely temporary, remains to be seen. It is far better to be conservative about such matters at the present time until one finds that the result of x-ray treatment is permanent.

Laryngitis.

As was stated above, *acute laryngitis* is almost invariably secondary to some infection higher up in the throat. Yet there are cases of primary, acute laryngitis, with direct localized irritation. Such cases respond very well to topical applications of argyrol and silver nitrate and inhalations of steam. When it comes to the *subacute or chronic conditions of the larynx,* one has to be more careful if he wishes to avoid having the patient succumb to some serious ailment. One must keep in mind the fact that almost all cases of subacute laryngitis, with hoarseness extending over a period of two or three months, are due to some other cause than a localized irritation. Either an ulceration is present upon the vocal cords or some paralysis or else a tumor formation, either benign or malignant. With the advent of the direct laryngoscope, it is easy to examine the larynx in such a way as to actually determine other varieties from the normal, and any pathological tissue which is present, particularly in the form of a growth, should be suspected of being of a malignant nature if it occurs during middle life. As soon as such a condition is suspected, the patient should be placed in the hands of some laryngologist who is expert with a direct laryngoscope, and a minute inspection of the larynx should be made. It may be necessary to make a diagnosis of a malignancy by simple inspection, and in other instances it may be necessary to remove a small piece of tissue. Unfortunately, when such tissue is removed, there is a tendency, if the growth is malignant, for it to increase rapidly in size. In any event, the patient should have the advantage of a

specialized examination so that it will not be possible for him to go on to the stage where an undiscovered growth invades the extra laryngeal tissues. The time for a life-saving operation has then passed. So many times mistakes are made because of superficial examinations, and so many times are the patients delayed in having the proper examination and treatment given, that one only sees the patient when the diagnosis is beyond doubt and when, often, it is too late to do more than make life more bearable by the insertion of a tracheal tube.

CONCLUSION.

The author, in this brief article, has attempted to bring out the symptoms, diagnosis and treatment of the commoner ailments of middle life. It has been impossible to cover the field with any exactitude or to go into details which are so necessary for the accurate treatment of diseases of the ear, nose, and throat. With the expansion of our knowledge, new methods of diagnosis and treatment are being discovered every day, with the result that the busy oto-laryngologist finds it hard to keep up with the times. It is no wonder, then, that the busy practitioner finds it impossible to do more than to gain a superficial knowledge of the subject. It is the wise man who knows that he knows little and who is willing to hand over the responsibility of the care of his patient to the physician who has made a life study of these special parts. The physician is not likely to err when he is taking care of an acute case. But how often one sees cases of progressive deafness or chronic laryngitis which have gone beyond the stage where any hope of relief can be given! In the one case, the patient leads a life of misery; in the other case, oftentimes a death warrant has been signed. Let us hope that, as time goes on, more time will be given, in our medical schools, to the study of these subjects, so that the student will have more than a superficial knowledge and will feel more assured that diseases of the nose, throat, and ear are just as important to the welfare of his patient as diseases in other parts of the body.

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